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EXTENDED ABSTRACT

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COMPARATIVE EFFICACY OF HOT AND COLD-WATER IMMERSION THERAPIES ON POST-MATCH RECOVERY IN FUTSAL PLAYERS: A QUASI-EXPERIMENTAL STUDY OF MUSCLE SORENESS, STRENGTH, AND KNEE RANGE OF MOTION

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I. Introduction

Hot and cold-water immersion therapies are popular recovery strategies for athletes [1]. This study investigates their effects on muscle soreness among futsal players, aiming to clarify their comparative benefits and mechanisms for optimizing post-exercise recovery [2].

II. Methods

This quasi-experimental study involves 18–25-year-old male futsal players from UiTM Negeri Sembilan, who are healthy and injury-free [3]. Baseline assessments include muscle soreness using the Visual Analog Scale (VAS) [4] and goniometer [5], sit-to-stand performance [6], knee extensor strength [7], and knee range of motion (ROM) [8]. After a 90-minute match, players undergo either hot (38–40°C) or cold-water immersion (11–15°C) for 15 minutes [9]. Muscle soreness and ROM are evaluated immediately post-intervention and at 24-, 48-, and 72-hours using repeated measures ANOVA.

III. Results and Discussion

A. Sit to stand

A repeated measures ANOVA found a significant effect of treatments on pain levels ($df = 4$, $p<0.001$) but no significant interaction effect ($df = 4,4$, $p = 0.543$) with a small effect size [3]. Comparison of treatments showed no significant difference in pain reduction ($F = 0.329$, $p = 0.573$), suggesting variability was due to chance, rejecting the null hypothesis for CWI and HWI effects on Sit-to-Stand performance [10].

B. Knee extensor

Similarly, the pain scale for knee extensor showed a significant effect of the pain scale ($df = 4$, $p<0.001$), indicating differences in pain levels across conditions [3]. However, the interaction between pain scale and treatment was not significant ($df = 4,4$, $p = 0.738$), nor was the comparison between treatments ($F = 0.095$, $p = 0.762$), with a small effect size [11]. These results suggest pain reduction variability is not due to the treatments but likely due to chance or other factors.

C. Knee Range of Motion

A repeated measures ANOVA showed a significant main effect of ROM ($df = 4$, $p<0.001$) and significant interaction with treatment ($df = 4$, $p = 0.002$), indicating varying treatment impacts on ROM with a small to moderate effect size [3]. However, another analysis found no significant main effect ($F = 1.84$, $p = 0.192$) or interaction, suggesting inconsistent results and requiring further investigation [11].

D. Comparing HWI and CWI Effects

CWI was more effective in reducing muscle soreness, with significant differences in ROM observed ($p<0.001$) [3]. The interaction effect was also significant ($p = 0.002$), indicating treatment-specific impacts [12]. Despite these findings, variability in ROM scores across conditions ($p = 0.192$) suggests differential impacts that require further exploration [13].

TABLE I
P-Value And Effect Size (Eta Square) Performance Scores (Sit to Stand, Knee Extensor) and Knee Range of Motion

Effect	*p*	Eta Square
PS (Sit to Stand)	<0.001	0.834
PS (Knee extensor)	<0.001	0.787
ROM	<0.001	0.141

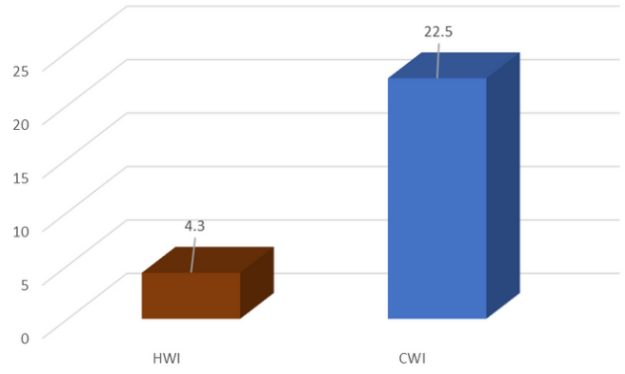

Fig. 1 Mean value of HWI and CWI on Sit to Stand

Figure 1 shows the mean Sit-to-Stand performance for HWI and CWI, with CWI (22.5) having a significantly greater effect than HWI (4.3). The large difference suggests that CWI enhances performance more effectively. The null hypothesis, which assumes no significant difference between HWI and CWI was rejected.

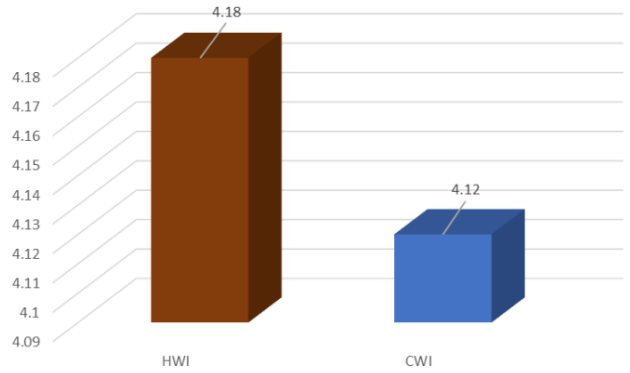

Fig. 2 A bar shows the mean value of HWI and CWI on Knee extensor

Figure 2 shows the mean value of HWI and CWI on PS Knee Extensor, with HWI (4.18) having a greater effect than CWI (4.12). The difference suggests that HWI may have a slightly higher impact on knee extensor performance compared to CWI. The null hypothesis, which assumes no significant difference between HWI and CWI, was rejected.

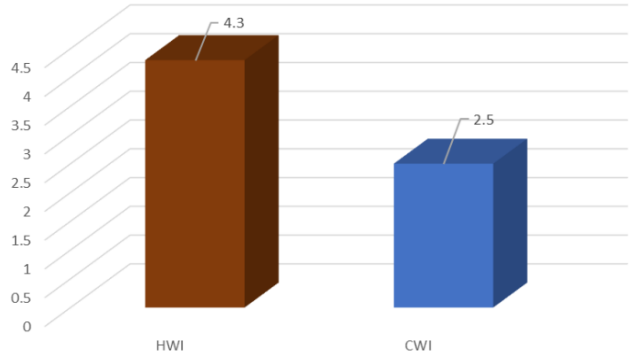

Fig. 3 A bar shows the mean value of HWI and CWI on Knee ROM

Figure 3 shows the mean knee ROM for HWI and CWI, with HWI (4.3) having a significantly greater effect than CWI (2.5). The large difference suggests that HWI enhances knee ROM more effectively. The null hypothesis, which assumes no significant difference between HWI and CWI, was rejected.

IV. Conclusions

Both HWI and CWI significantly reduced muscle soreness among futsal players, with CWI demonstrating slightly greater effectiveness in enhancing recovery. However, differences in the ROM outcomes suggest treatment-specific impacts requiring further investigation. These findings highlight the importance of tailored recovery strategies for optimizing post-exercise recovery in athletic contexts.

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