

COLD WATER IMMERSION DID NOT ACCELERATE RECOVERY AFTER A FUTSAL MATCH



IMERSÃO EM ÁGUA FRIA NÃO ACELEROU A RECUPERAÇÃO APÓS UMA PARTIDA DE FUTSAL

LA INMERSIÓN EN AGUA FRÍA NO ACELERÓ LA RECUPERACIÓN DESPUÉS DE UN PARTIDO DE FUTSAL

ARTIGO ORIGINAL

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ABSTRACT

Introduction: cold-water immersion (CWI) is a popular recovery strategy; however, there is limited evidence of the effectiveness of this method in sport settings. **Objective:** to investigate the effect of CWI on muscle soreness and anaerobic performance after a Futsal match. **Methods:** ten players performed two simulated matches followed by two randomized recovery conditions (CWI or passive rest - C), separated for seven days. During the recovery interventions, the players remained seated in a comfortable position (C) or were immersed in a pool with cold water (CWI condition; $15\pm 1^\circ\text{C}$) for 12 minutes. Muscle soreness assessment, counter movement jump (CMJ) test, repeated jump ability (RJA) test, and repeated sprint running test (rRST) were conducted prior to the match (Pre), immediately after the recovery intervention (P1) and 24h after the recovery intervention (P2). **Results:** a significant increase in muscle soreness after the Futsal match was observed for both interventions (C and CWI) during all time points (P1 and P2, $p < 0.05$); however, no significant difference was detected between CWI and C interventions ($p > 0.05$). There was a significant decrease in anaerobic performance (CMJ, RJA and rRST) immediately after the CWI intervention when compared to C (P1, $p < 0.05$). No significant difference in anaerobic performance was detected between the two conditions at P2 (CWI and C; $p > 0.05$). **Conclusion:** the CWI did not improve recovery related to muscle soreness and anaerobic performance of Futsal players.

Keywords: fatigue, muscle soreness, vertical jump, repeated sprint ability.

RESUMO

Introdução: a imersão em água fria (IAF) é uma estratégia popular de recuperação, no entanto, há poucas evidências sobre a eficácia desse método no contexto do esporte. **Objetivo:** investigar o efeito da IAF sobre a dor muscular e o desempenho anaeróbico após uma partida de Futsal. **Métodos:** dez jogadores participaram de duas partidas simuladas, seguidas por duas condições de recuperação randomizadas (IAF ou repouso passivo), separadas por sete dias. Durante as intervenções de recuperação, os jogadores permaneceram sentados em uma posição confortável (C) ou foram imersos em uma piscina com água fria (condição IAF; $15\pm 1^\circ\text{C}$) por 12 minutos. A avaliação da dor muscular, o teste de salto movimento contra (SCM), o teste de saltos repetidos (TSR) e o teste de sprints repetidos (TSR) foram realizados antes da partida (PRÉ), imediatamente após a intervenção de recuperação (P1) e 24h depois da intervenção de recuperação (P2). **Resultados:** foi observado aumento na sensação de dor muscular após a partida de Futsal para ambas as intervenções (IAF e C) (P1 e P2, $p < 0,05$); no entanto, não houve diferença entre as intervenções (IAF e C; $p > 0,05$). Houve diminuição no desempenho anaeróbico (SCM, TSR e TSR) imediatamente após a intervenção IAF quando comparado ao C (P1, $p < 0,05$). Não houve diferença no desempenho anaeróbico entre as duas condições no P2 (IAF e C; $p > 0,05$). **Conclusão:** a IAF não melhorou a recuperação relacionada à dor muscular e o desempenho anaeróbico de jogadores de Futsal.

Palavras-chave: fadiga, dor muscular, salto vertical, capacidade de sprints repetidos.

RESUMEN

Introducción: la inmersión en agua fría (IAF) es una estrategia de recuperación popular, sin embargo, la evidencia de la efectividad de este método en el ámbito deportivo es limitada. **Objetivo:** investigar el efecto de la IAF en el dolor muscular y en el rendimiento anaeróbico después de un partido de Futsal. **Métodos:** diez jugadores realizaron dos partidos simulados seguido de dos condiciones aleatorias de recuperación (IAF o descanso pasivo - C) separado por siete días. Durante las intervenciones de recuperación, los jugadores se sentaron en una posición cómoda (C) o se sumergieron en una piscina con agua fría (condición de la IAF; $15\pm 1^\circ\text{C}$) durante 12 minutos. La evaluación del dolor muscular, la prueba de salto contra movimiento (SCM), prueba de saltos repetidos (PSR) y la prueba de sprints repetidos (PSPR) se realizaron antes del partido (PRE), inmediatamente después de la intervención de recuperación (P1) y 24 horas después de la intervención de recuperación (P2). **Resultados:** la sensación de dolor muscular aumentó después de partido de Futsal para ambas intervenciones (IAF y C) (P1 y P2; $p < 0,05$); sin embargo, sin diferencia entre las intervenciones (IAF y C; $p > 0,05$). El rendimiento anaeróbico disminuyó (SCM, PSR y PSPR) inmediatamente después de la intervención de IAF en comparación con C (P1, $p < 0,05$). No hubo diferencias en el rendimiento anaeróbico entre las dos condiciones en P2 (IAF y C; $p > 0,05$). **Conclusión:** el IAF no ha mejorado la recuperación relacionada con el dolor muscular y rendimiento anaeróbico de los jugadores de Futsal.

Palabras clave: fatiga, dolor muscular, salto vertical, capacidad de sprints repetidos.

INTRODUCTION

There is a growing interest on interventions to accelerate the recovery process so athletes might perform successive training sessions or competitive matches without a significant decrement of performance. Recently, cold-water immersion (CWI) has emerged as one of the most popular interventions to accelerate recovery after exercise^{1,2}. However, there is limited data regarding the effectiveness of this intervention in sport-specific settings.

Research on CWI interventions to accelerate recovery show conflicting results since some studies suggest positive outcomes³⁻⁵ while others report non-significant effects⁶⁻⁸. Despite this controversy, athletes has been used CWI to promote a faster recovery, to diminish muscle soreness, and to hasten a return to optimal performance^{1,2,9}. As a specific example, CWI has been largely utilized by Brazilian Futsal players between successive training sessions and competitive matches. However, there is insufficient evidence to support the use of this strategy following Futsal training sessions and competitive matches.

Futsal is a high intensity intermittent sport that relies on mixed contribution of anaerobic and aerobic energy systems¹⁰. Barbero-Alvarez *et al.*¹¹ and Castagna *et al.*¹⁰ have shown that the Futsal match demands are higher than soccer and other intermittent team sports. Futsal physical demands indicate that the competitive match might induce severe fatigue, and may require efficient recovery interventions.

To date, no previous study has been conducted to verify the impact of CWI on muscle soreness and anaerobic performance of top-level Futsal players following a match. Therefore, the purpose of the present study was to investigate the effect of CWI on muscle soreness and anaerobic performance after a simulated match. The authors hypothesized that CWI would attenuate muscle soreness and minimize performance decrement thus accelerating recovery.

METHODS

The present study was conducted at the beginning of the competitive season (State Championship). The Futsal team involved in this study finished the season in the second position. All players were familiar with testing procedures used in the investigation. Players performed two highly competitive simulated matches (four quarters of 10 min with 5-min recovery period) separated by seven days in an ecological setting, using procedures previously described^{10,12}. It is important to highlight that verbal encouragement was provided by the coaches during both matches. Each match was followed by one of two recovery interventions, a passive recovery (Control - C) or a CWI intervention. The respective interventions were randomized and performed at the same time of day to avoid diurnal variation. Thus, the order of recovery intervention (CWI and C) was individually counterbalanced. The recovery interval from the last bout of exercise was more than 48 h. To assess match intensity, a rating of perceived exertion (RPE) was recorded for all players after each match using Borg's CR-10 scale¹³. The players were familiarized with this procedure during prior training sessions.

To determine the effect of CWI on muscle soreness and anaerobic performance, the assessments were conducted prior to the match (Pre), immediately after the recovery intervention (P1) and 24h after the recovery intervention (P2). During the recovery intervention, the players remained seated in a comfortable position (control condition; C) or were seated (immersed) in a plunge pool set at $15 \pm 1^\circ\text{C}$ for 12 min (CWI condition). The experimental design is illustrated by figure 1.

Ten male professional Futsal players (age: 24 ± 3 years, height: 174 ± 5 cm, body mass: 73 ± 9 kg) volunteered to participate in this study. The athletes belonged to a team from the Professional National

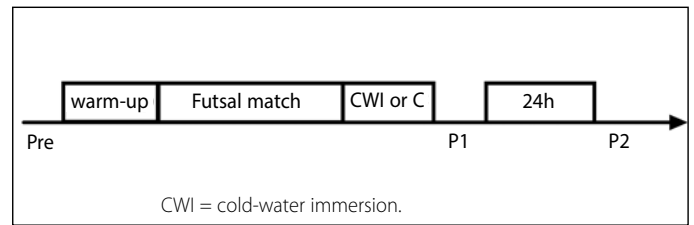


Figure 1. Schematic representation of the experimental design of the study.

Brazilian Futsal League. Players trained five days per week and played one match per week. All the participants were volunteers and took part in the present study after giving their signed consent. All procedures received Institution Ethics Committee approval.

Muscle soreness was assessed using a visual analog scale (VAS) of 100 mm line with "no pain" on one side and "extremely sore" on the other^{14,15}. The athletes recorded the magnitude of muscle soreness during the stretching of *biceps femoralis* muscle¹⁴.

The performance tests were conducted at the three time points: before the match (Pre), 10 min after the recovery intervention (P1), and 24h after the recovery intervention (P2). All players were assessed in the same order in all time points. The counter movement jump (CMJ) was performed according to subject's own preferred style as suggested by Bobbert *et al.*¹⁶. Subjects performed three CMJ trials on a jump mat (Jump System Pro® – Cefise®, Brazil), and the best result was recorded. The repeated jump ability test (RJA) and the repeated sprint running test (rRST) were performed in this sequence. The RJA test was conducted according previous procedure¹⁷. In the RJA test, the players had just 1 attempt on a continuous countermovement rebound jump for 15 seconds without any recovery between jumps on a jump mat (Jump System Pro® – Cefise®, Brazil)¹⁷. The average of height of all jumps was considered for analysis. The players were instructed to jump as high as possible with their hands on their hips and to keep foot contact on the mat as short as possible. The RJA showed an ICC of 0.79. The rRST consisted of five 30-m sprints, each separated by a 25-s period of active recovery (jogging)¹⁸. Infrared light sensors with a precision of 0.01 s recorded the sprint times (Cefise®, Brazil). The mean sprint time was considered for analysis. The rRST showed an intraclass correlation coefficient (ICC) of 0.93.

Statistical Analyses

The distribution of the data was analyzed by the Shapiro-Wilk test. The Mauchly's Test of Sphericity was performed to test the null hypothesis that the error covariance matrix of the orthonormalized-transformed dependent variables was proportional to an identity matrix. Two-way ANOVA with repeated measures was used to compare the two recovery procedures on three time points (Pre, P1 and P2). Tukey HSD post hoc test was utilized when necessary. In the case of violation of the assumption of sphericity, the significance was established by utilizing the Greenhouse-Geisser correction.

RESULTS

A similar session rating of perceived exertion (RPE) was observed for the two simulated matches (1st match: 6.8 ± 1.4 , "hard" to "very hard"; 2nd match: 6.7 ± 1.2 , "hard" to "very hard").

Figure 2 shows the muscle soreness of Futsal players. A significant increase in muscle soreness after the Futsal match was observed for both interventions during all time points (P1 and P2); however, no significant difference ($p > 0.05$) was detected between CWI and C interventions. The results of the anaerobic performance tests (CMJ, RJA and rRST) are shown in figures 3, 4 and 5. There was a significant decrease in anaerobic performance (CMJ, RJA and rRST) immediately following

the CWI intervention when compared to C intervention (P1, $p < 0.05$). No significant difference in anaerobic performance was detected between CWI and C at P2 ($p > 0.05$).

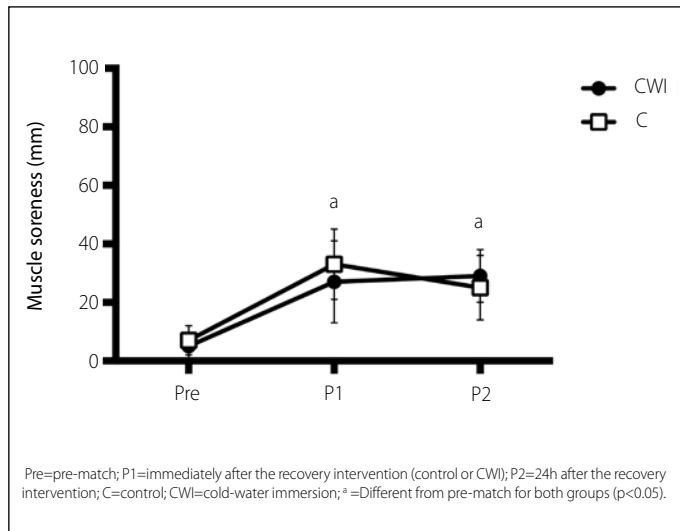


Figure 2. Muscle soreness following the Futsal matches.

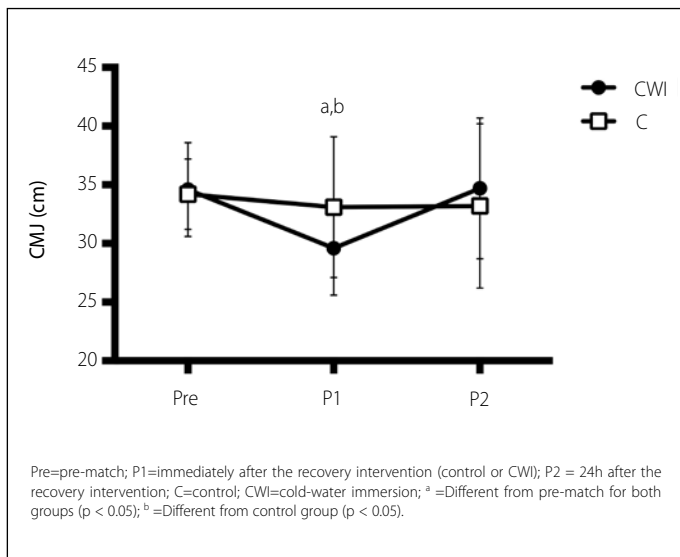


Figure 3. Counter movement jumping following the Futsal matches.

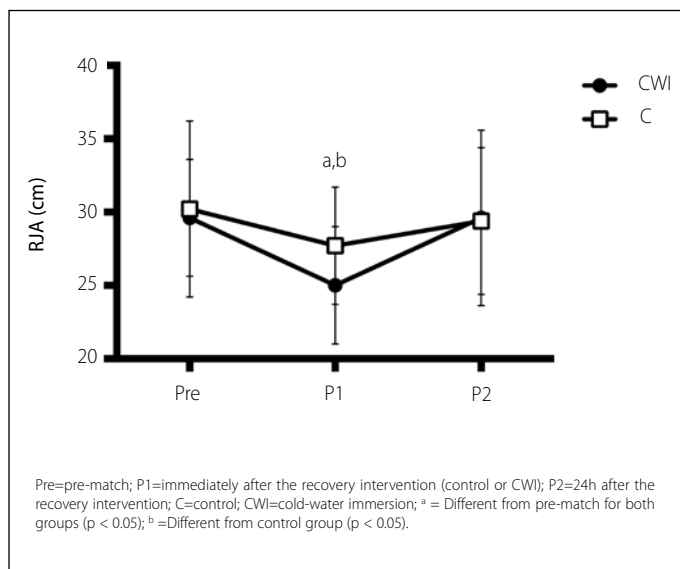


Figure 4. Repeated jumping ability following the Futsal matches.

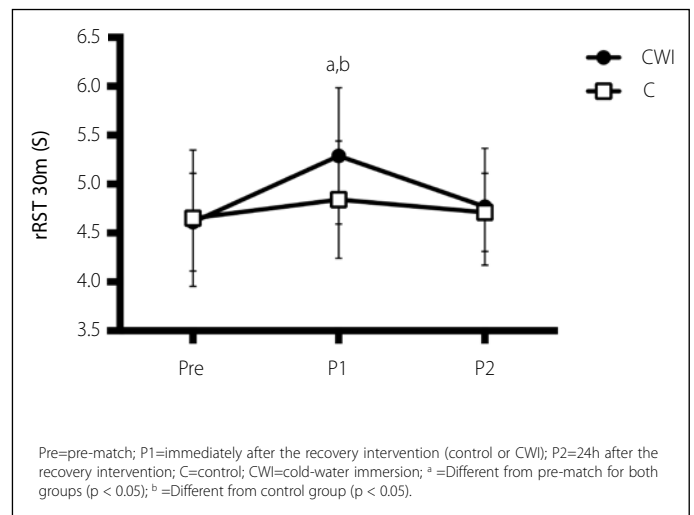


Figure 5. Repeated sprint running test following the Futsal matches.

DISCUSSION

The present study aimed to compare the effect of two recovery methods (passive and CWI) performed after a simulated Futsal match. This is the first study that analyzed the effect of CWI on muscle soreness and anaerobic performance after a Futsal match in top-level Brazilian professional players. The major findings of the present study were as follows: 1) CWI did not attenuate the magnitude of muscle soreness induced by a simulated Futsal match, 2) A significant decrease in the post-match anaerobic performance was observed immediately after the CWI intervention and 3) no difference in anaerobic performance was observed between both interventions after 24h.

The mean RPE score for both matches was similar (~7.0), indicating a perceived exertion between “hard” and “very hard”. Tessitore *et al.*¹⁹ showed that young Futsal players perceived the mean intensity from four friendly matches as “somewhat hard” using the Borg’s 6-20 Scale. These findings highlight that players attained a high-intensity effort during both matches. Previous studies confirm the high physiological demands of Futsal matches^{10,11,20}.

Nowadays many athletes and coaches habitually use CWI after intense training sessions or competitive matches expecting that this intervention will accelerate recovery¹². To date, only one study has investigated recovery procedures in Futsal players¹⁹, but the sample were composed by young players, members of college Futsal teams. Furthermore, Tessitore *et al.*¹⁹ did not evaluate the impact of CWI as a recovery strategy.

In the present study, CWI intervention did not decrease the magnitude of muscle soreness after the match (24h post-intervention) when compared to the passive recovery (C). In agreement with the findings of the present study, Jakeman *et al.*²¹ also showed that a single bout of CWI (10 min at 10°C) following a damaging exercise (10 sets of 10 counter-movement jumps) has no beneficial effect on perceived muscle soreness during recovery (1, 24, 48, 72, and 96h after the exercise). Yanagisawa *et al.*²² also did not observe a positive effect of CWI (15 min at 5°C) on muscle soreness attenuation after a damaging exercise (ankle plantar flexion; five sets of 12 repetitions) up to 168h post-protocol. In addition, Goodall & Howatson²³ investigated the effect of multiple CWI (12 min at 15°C - applied immediately post-exercise, 24, 48, 72, and 96 h) after the exercise bout (five sets of 20 drop jumps) on perceived muscle soreness assessed at these same time points. These authors did not observe a positive effect of this strategy on the muscle soreness when compared to the control group at any time analyzed.

However, other investigations showed that CWI attenuates muscle soreness⁴⁵. The recent meta-analyses conducted by Leeder *et al.*¹ and Bleakley *et al.*² showed that CWI is effective to alleviating muscle sore-

ness after damaging exercise between 24h up to 96 h of its application. One mechanism that has been proposed to explain the attenuation of muscle soreness is that CWI causes reduction in muscle blood flow and tissue temperature, lowering the inflammation induced by high-intensity damaging exercise. This intentional reduction of inflammation might be related to attenuation of DOMS¹.

Regarding to the effect of CWI on physical performance the results are also diverse and inconsistent^{1,2}. The results of the present study indicated that CWI may impact negatively in anaerobic performance assessed immediately after the intervention. A significant decrease in CMJ, RJA and rRST performance was observed immediately after the CWI. In line with these results, Crowe *et al.*⁸ observed a decrease in anaerobic performance (30-s "all out" maximal cycling test) after CWI (15 min at 13-14°C). In this study, peak power, total work and post-exercise blood lactate were significantly reduced following CWI compared to the first exercise test and the control condition⁸. Buchheit *et al.*²⁴ did not show a significant difference in mean power output and completion time during 1-km cycling time trials between the CWI (5 min at 14°C) and passive recovery in male cyclists, despite the improvement of perceived rating of recovery after the CWI. Likewise, Jakeman *et al.*²¹ showed that after a damaging exercise, the CWI did not show a positive effect from recovery of maximal voluntary contraction of the quadriceps up to 96h after its application when compared to the passive recovery.

In the present study, the decrease in anaerobic performance immediately after the CWI could be explained by the lower muscle temperature. The possible mechanisms involved in the performance deterioration include decreased stiffness of muscle and joints, increased transmission rate of nerve impulses, altered force-velocity relationship and increased glycogenolysis, glycolysis, and high-energy phosphate degradation²⁵. Therefore, a lower muscle temperature immediately after the CWI might have impaired muscle contractile ability and exercise performance. García-Manso *et al.*²⁶ showed that CWI may modify skeletal muscle physiology of professional soccer players, increasing stiffness and decreasing muscle contraction velocity. On the other hand, the benefits of warm-up

on the short-term neuro-muscular performance appear to be largely, although not entirely, attributable to the increase in muscle temperature²⁵.

More recently, Stanley *et al.*²⁷ investigated the effects of CWI on both central (i.e., cardiac output) and peripheral (i.e., muscle oxygenation) facilitators of O₂ delivery to exercising muscle. In addition, these researchers also assessed the influence of CWI on the anaerobic contribution during subsequent high-intensity interval training (HIIT)²⁷. Interestingly, they showed that using CWI prior to a subsequent HIIT led to increased cardiac parasympathetic activity, slowed VO₂ on-kinetics and reduced muscle O₂ utilization, probably due to the reduced muscle blood flow²⁷. In addition, CWI increased anaerobic contribution during HIIT²⁷. These central and peripheral responses seem to persist up to 45 min. From the practical point of view, the authors suggest that athletes should be advised to not use CWI if high-intensity events are separated by 45 min or less.

CONCLUSION

In summary, the results of the current study indicate that a single bout of CWI after a simulated Futsal match had no beneficial effect on perceived muscle soreness and anaerobic performance during a short-term recovery period. However, additional studies are necessary to analyze the effect of different CWI protocols on recovery of Futsal players during tournaments with subsequent matches in a short period of time.

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All authors have declared there is not any potential conflict of interests concerning this article.

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