THE EFFECTS OF RECOVERY MODALITIES INCLUDING ICE BATH IMMERSION ON RECOVERY FROM EXERCISE AND SUBSEQUENT PERFORMANCE

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The purpose of this study was to examine the effects of recovery modalities on recovery and subsequent performance. Ten trained male rugby union players were tested three times completing a different, randomly assigned recovery modality on each occasion. Each test began with a maximal aerobic endurance field test (20 metre shuttle test) followed by one of three recovery strategies – passive recovery, active recovery or ice bath immersion. Passive recovery involved lying on a recovery bed for 20 mins; active recovery entailed cycling for 20 mins at 50% heart rate reserve; and ice bath immersion required subjects to sit waist deep in an ice bath (5-8°C) for 3 x 30 s repetitions separated by one minute standing outside the bath. Following the 45 minute post-recovery strategy period, subjects completed 6 shuttles of a timed performance test (Illinois agility test). Plasma lactate concentrations and muscle soreness ratings were measured at various intervals throughout the testing. Analysis of the data revealed that active recovery resulted in significantly greater rates of lactate removal 5 mins into the recovery strategy when compared to passive recovery ($p = 0.01$). Muscle soreness was significantly lower for ice bath immersion than for active recovery immediately after the 20 minute recovery period ($p = 0.006$). No significant differences were observed for the subsequent performance test.

KEY WORDS: Recovery, ice bath immersion, subsequent performance.

INTRODUCTION: For decades various cryotherapies have been adopted for injury rehabilitation and more recently as a modality to accelerate the recovery process and enhance subsequent athletic performance. Many variations of cryotherapy are commonly used including cryo-chambers, ice pack therapy and ever more prevalently, ice baths, which are a focus of the present study. Due to the lack of definitive scientific evidence to support the efficacy of ice baths or any clear explanation of the possible mechanisms underlying their usage, there are currently no standardised procedures for their usage with a wide variety of recovery protocols being adopted. As a consequence, further research is required investigating ice bath immersion as a recovery strategy, which focuses on methodological issues such as specific temperature of the bath, repetitions, intervals between multiple repetitions, training effects associated with repeated use of ice bath immersion as a recovery strategy (Cochrane, 2004) and the effect of this recovery modality on subsequent performance. Recovery is an evolving area in sport. Recovery strategies are now not only being used extensively for treatment and rehabilitation from injury, but also to accelerate the recovery process from training and optimise subsequent athletic performance. The use of ice baths as a recovery strategy in particular has gained widespread popularity in recent times. Despite this there is a dearth of scientific evidence to support their usage. The aim of this study was to investigate the effects of three different recovery modalities (passive recovery, active recovery and ice bath immersion) both on recovery from exercise but also subsequent high intensity exercise performance.

METHODS: Data Collection: 10 healthy male subjects, aged between 18-30 years, volunteered to participate in the study. All experimental procedures were approved by the Dublin City University Research Ethics Committee. Subjects consisted of trained club rugby players of Junior 2 level or above and were recruited from Leinster rugby clubs. Subjects were restricted to backs position players to keep the groups as homogenous as possible. The descriptive and anthropometric data for the 10 subjects are presented in Table 1.

The study took place at the sports science facilities at Dublin City University (DCU). The subjects visited DCU on three separate occasions, with each visit separated by no less than a week. Each visit was divided into 2 stages separated by a 45 minute post-recovery period, during which nutrition, fluid intake and activity levels were monitored closely.

Table 1: Descriptive Anthropometric Data

Descriptive Anthropometric Data, n=10	(Mean(±SD))
Age (yrs)	21 (± 2.3)
Height (m)	1.76 (± 0.08)
Mass (kg)	73.3 (± 6.05)
Body mass index (kg.m^{-2})	23.5 (± 0.9)
Mean 20MST Score (mins elapsed)	12 (± 1.1)
Resting heart rate (bpm)	58 (± 13.7)
Target heart rate for active recovery (bpm)	130 (± 10.1)

The first part of the visit lasted approximately 35 mins and involved anthropometric measurements, a maximal endurance 20 metre shuttle run test (Leger and Lambert, 1982) and completion of one recovery strategy. Blood lactate measurements and muscle soreness ratings were recorded before testing began and at various intervals throughout each visit as outlined below:

- Sample A: Baseline resting measurement prior to 20MST
- Sample B: Immediately post-maximal test
- Sample C: 5 mins into the recovery strategy (equivalent to end of ice bath)
- Sample D: Immediately post recovery strategy (15 mins post ice bath)
- Sample E: Immediately pre-subsequent performance (after 45 minute period)
- Sample F: Immediately post-subsequent performance

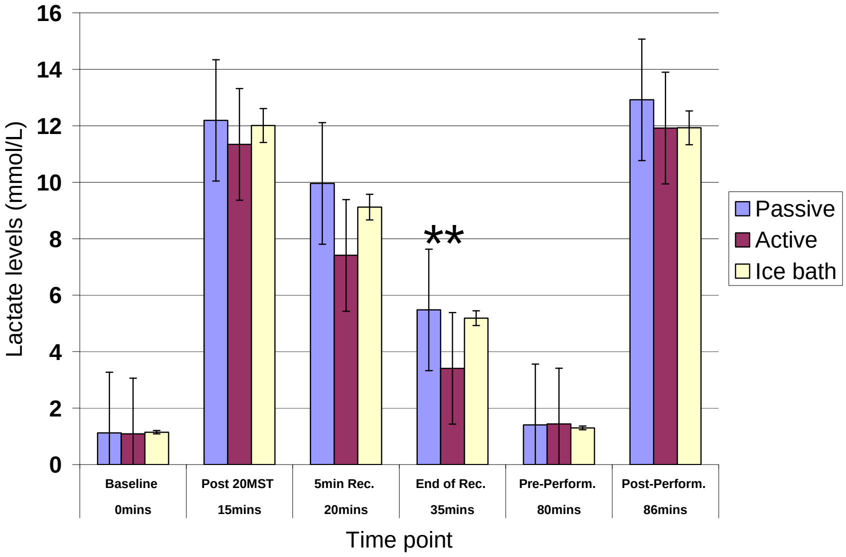
Blood lactate measurements were obtained by drawing 1ml of blood from the earlobe onto a lactate strip and inserting into a blood lactate analyser (Lactate Pro^{TM}, Quesnel, Canada). Muscle soreness was rated using an 11 point scale (0-10) adapted from the differential descriptor scale (DDS) from Gracely et al. (1978).

Passive recovery involved the subjects lying supine on a recovery bed for a total of 20 mins with as little movement as possible. Active recovery consisted of the subjects cycling on a cycle ergometer (Monark^{TM}, UK) for 20 mins at a pace that corresponded to 50% of their heart rate reserve (HRR). The target heart rate (THR) was calculated using the Karvonen method involving the following equation: THR: ((HR_{max} – HR_{rest}) x % intensity) + HR_{rest}. The ice bath recovery strategy was conducted by filling an ice bath (Symbol^{TM}, UK) with water to a level of 35cm and ice was used to keep the temperature constant in the range of 5-8°C using a 110mm immersion thermometer. The subject was then immersed in the bath to waist height with legs outstretched. Subjects completed three bouts of 30 s ice bath immersions with a 1 minute break in between each bout, in which the subject exited the bath. The subject was then instructed to remain seated for 15 mins after which time blood sample D and muscle soreness ratings were collected to coincide with the termination of the passive and active recovery strategies. Following each 20 minute recovery strategy period, subjects were given instructions regarding physical activity, hydration and nutrition for the 45 minute rest period before completing the subsequent performance test.

Following the 45 minute post-recovery period, subjects completed the second stage of the test which involved 6 shuttles, with 20 s recovery between each shuttle, of the Illinois agility test (Foran, 2001), which was used as the performance measure by which the recovery strategies were assessed. Muscle soreness ratings and blood samples E and F were taken immediately before and after the performance test respectively.

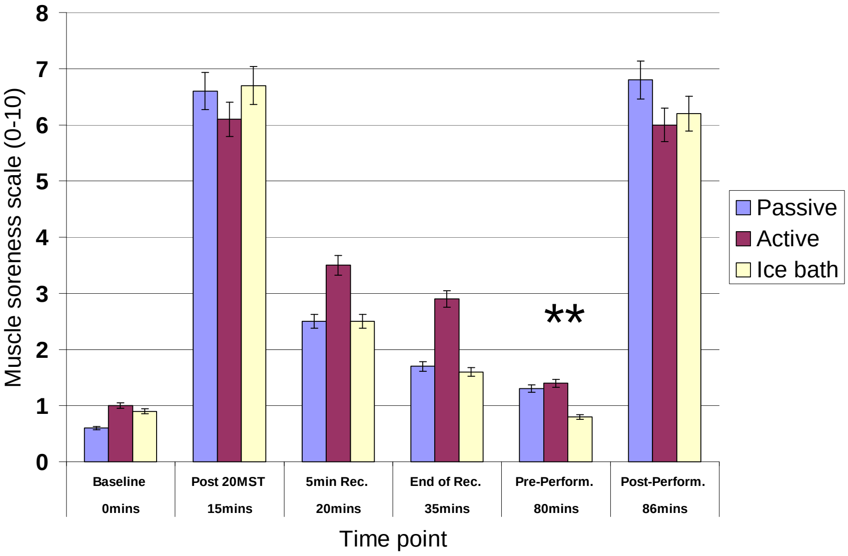
Data Analysis: SPSS for Windows v.15.0 (SPSS, USA) was used to conduct the statistical analysis. An analysis of variance (ANOVA) with repeated measures was carried out to determine any statistical significance between recovery groups at each of the six different time points. Post-hoc testing with Bonferroni adjustment was carried out along with tests of normality and Mauchly's test of sphericity. A probability of 0.05 was used to ascertain significance.

RESULTS: There were no significant differences in maximal endurance performance (20MST), baseline lactate levels and baseline muscle soreness ratings between subjects and within subjects across trials suggesting a large degree of homogeneity among the subjects. The active recovery modality exhibited significantly greater rates of lactate removal ($p = 0.01$) when compared to passive recovery at 5 mins into the recovery strategies (Figure 1).



*(** = p<0.01, *= p<0.05)*
Figure1: Comparison of lactate levels for each recovery strategy.

The only other significant difference between trials was immediately following the 20 minute recovery period where ice bath immersion was associated with significantly lower muscle soreness ratings *($p = 0.006$)* when compared to active recovery (Figure 2).



*(**= p<0.01, *= p<0.05)*
Figure 2: Comparison of muscle soreness ratings for each recovery strategy.

DISCUSSION: Ice bath immersion is one of the most popular recovery strategies used in team sports such as rugby. Despite this, research to support its effectiveness as a recovery modality is limited and contradictory (Barnett, 2006). In terms of the recovery indices measured, significant differences were observed for blood lactate clearance for active recovery compared to passive recovery *($p = 0.01$)*. However, no differences in subsequent performance were observed between the three recovery strategies investigated. This suggests that lactate removal rates may not be related to performance, in terms of muscle function in the current exercise trial. This finding is supported by Bond et al. (1991).

Upon completion of the 20 minute recovery strategy period muscle soreness ratings were found to be significantly lower for ice bath immersion when compared to active recovery *($p = 0.006$)*. The significantly greater muscle soreness associated with active recovery compared to ice bath immersion may be attributed to the intensity at which the active recovery strategy was implemented (50% heart rate reserve) compared to ice bath immersion which consisted of effectively 15 mins of passive rest following the 5 minute strategy. Another possible explanation relates to subjects' perception of the benefits of ice bath immersion as a recovery strategy. From the ice bath questionnaire completed prior to testing, 40% of the subject group envisaged a decrease in muscle soreness and an increase in performance with ice bath immersion. Alternatively, the reduced muscle soreness may be a delayed effect of the ice bath immersion recovery strategy.

The present study revealed that no significant differences were found in mean performance agility times, across trials for any of the three recovery strategies *($p = 1.000$)*.

The specific recovery protocols adopted in the study involved a relatively short post-exercise recovery period of 45 mins, in the anticipation that the effects of the recovery strategies would still be evident and thus, significant differences in performance may have been observed. However, as is shown in the results, lactate and muscle soreness levels had almost returned to baseline following the 45 minute post-recovery period and no significant differences were detected at this time point. Therefore, there are grounds for further research to incorporate even shorter post-exercise recovery periods. A period of 10-15 mins would typically replicate the half time interval in a team sport such as rugby union and as a result any findings may have practical connotations in this respect.

CONCLUSION: The findings of this study question the efficacy of ice bath immersion as an effective strategy to improve recovery and enhance performance. Furthermore ice baths appear to offer no additional advantage over more traditional recovery methods such as active recovery. To date much of the evidence to support the use of ice baths has been anecdotal with a distinct lack of scientific evidence. Therefore, despite their increasing popularity and use by many sports teams, none of the recovery strategies investigated in this study demonstrated any significant effect on performance.

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