

Impact of cold-water immersion compared to passive recovery following a single bout of strenuous exercise on athletic performance in trained participants: A systematic review with meta-analysis and meta-regression; Sports Medicine; Emma Moore (University of South Australia), Joel T Fuller (Macquarie University), Jonathan D Buckley (University of South Australia), Sienna Saunders (University of South Australia), Shona L Halson (McAuley at Banyo), James R Broatch (Victoria University), Clint R Bellenger (University of South Australia); Corresponding Author: emma.moore@mymail.unisa.edu.au

### Risk of Bias

Green = Yes; Yellow = Can't Say; Red = No; Blue = Does Not Apply

| # | Author, Year               | Title  | 1.1<br>focused<br>question | 1.2<br>randomised<br>groups | 1.3<br>concealment | 1.4<br>blinded<br>allocation | 1.5<br>similar<br>groups | 1.6<br>treatment | 1.7<br>outcomes | 1.8<br>drop<br>out | 1.9<br>analysis | 1.10<br>comparable<br>results | 2.1<br>Final<br>Ranking |
|---|----------------------------|--|----------------------------|-----------------------------|--------------------|------------------------------|--------------------------|------------------|-----------------|--------------------|-----------------|-------------------------------|-------------------------|
| 1 | Adamczyk et al 2016        | The Use of Thermal Imaging to assess the Effectiveness of Ice Massage and CWI as methods for supporting post Exercise Recovery | Green                      | Yellow                      | Red                | Yellow                       | Green                    | Green            | Green           | 0                  | Green           | Blue                          | +                       |
| 2 | Amir et al 2017            | The effect of single bout of 15mins of 15C CWI on DOMS indicators  | Green                      | Yellow                      | Red                | Yellow                       | Green                    | Green            | Green           | 0                  | Green           | Blue                          | +                       |
| 3 | Anderson et al 2017        | Effect of Cold (14C) V Ice (5C) water immersion on recovery from intermittent running exercise                                 | Green                      | Yellow                      | Red                | Yellow                       | Green                    | Green            | Green           | 0                  | Green           | Blue                          | +                       |
| 4 | Argus et al 2017           | CWI and CWT: No improvement of short-term recovery after resistance training   | Green                      | Yellow                      | Red                | Yellow                       | Green                    | Green            | Green           | 0                  | Green           | Blue                          | +                       |
| 5 | Bailey et al 2007          | Influence of CWI on indices of muscle damage following prolonged intermittent shuttle running                                  | Green                      | Green                       | Red                | Yellow                       | Green                    | Green            | Green           | 0                  | Green           | Blue                          | ++                      |
| 6 | Barber et al 2017          | The efficacy of repeated CWI on recovery following a simulated rugby union protocol  | Green                      | Yellow                      | Red                | Yellow                       | Green                    | Green            | Green           | 0                  | Green           | Blue                          | +                       |
| 7 | Bosak et al 2009           | Impact of CWI on 5km racing performance  | Green                      | Red                         | Red                | Yellow                       | Green                    | Green            | Green           | 0                  | Green           | Blue                          | -                       |
| 8 | Brophy-Williams et al 2011 | Effect of immediate and delayed cold water immersion after a high intensity exercise session on subsequent run performance     | Green                      | Red                         | Red                | Yellow                       | Green                    | Green            | Green           | 0                  | Green           | Blue                          | -                       |

| #  | Author,<br>Year        | Title   | <u>1.1</u><br>focused<br>question | <u>1.2</u><br>randomised<br>groups | <u>1.3</u><br>concealment | <u>1.4</u><br>blinded<br>allocation | <u>1.5</u><br>similar<br>groups | <u>1.6</u><br>treatment | <u>1.7</u><br>outcomes | <u>1.8</u><br>drop<br>out | <u>1.9</u><br>analysis | <u>1.10</u><br>comparable<br>results | <u>2.1</u><br>Final<br>Ranking |
|----|------------------------|---|-----------------------------------|------------------------------------|---------------------------|-------------------------------------|---------------------------------|-------------------------|------------------------|---------------------------|------------------------|--------------------------------------|--------------------------------|
| 9  | Crowther et al 2017    | Influence of recovery strategies upon performance and perceptions following fatiguing exercise: a RCT |                                   |                                    |                           |                                     |                                 |                         |                        | 5                         |                        |                                      | +                              |
| 10 | Crystal et al 2013     | Effect of cryotherapy on muscle recovery and inflammation following a bout of damaging exercise       |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 11 | Dantas et al 2019      | CWI does not accelerate performance recovery after 10km street run: RCCT                              |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | ++                             |
| 12 | Delextrat et al 2013   | Effects of sports massage and intermittent CWI on recovery from matches by basketball players         |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 13 | Doeringer et al 2018   | The effects of postexercise cooling on muscle performance and soreness perception                     |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | ++                             |
| 14 | Elias et al 2012       | Effects of water immersion on post training recovery in Australian footballers                        |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 15 | Elias et al 2013       | Effectiveness of water immersion on postmatch recovery in elite professional footballers              |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 16 | Eston et al 1999       | Effects of CWI on the symptoms of exercise induced muscle damage                                      |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 17 | Fonseca et al 2016     | Use of CWI to reduce muscle damage and DOMS and preserve muscle power in Jiu-Jitsu athletes           |                                   |                                    |                           |                                     |                                 |                         |                        | 4                         |                        |                                      | +                              |
| 18 | Getto et al 2013       | Comparison of active recovery in water and CWI after exhaustive exercise                              |                                   |                                    |                           |                                     |                                 |                         |                        | 7                         |                        |                                      | +                              |
| 19 | Goodall et al 2008     | The effects of multiple CWI on indices of muscle damage   |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 20 | Hassan 2011            | Thermal therapy and DOMS  |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 21 | Higgins et al 2013 (1) | Acute response to hydrotherapy after a simulated game of rugby  |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |

| #  | Author,<br>Year           | Title   | <u>1.1</u><br>focused<br>question | <u>1.2</u><br>randomised<br>groups | <u>1.3</u><br>concealment | <u>1.4</u><br>blinded<br>allocation | <u>1.5</u><br>similar<br>groups | <u>1.6</u><br>treatment | <u>1.7</u><br>outcomes | <u>1.8</u><br>drop<br>out | <u>1.9</u><br>analysis | <u>1.10</u><br>comparable<br>results | <u>2.1</u><br>Final<br>Ranking |
|----|---------------------------|---|-----------------------------------|------------------------------------|---------------------------|-------------------------------------|---------------------------------|-------------------------|------------------------|---------------------------|------------------------|--------------------------------------|--------------------------------|
| 22 | Higgins et al<br>2013 (2) | Evaluation of hydrotherapy, using passive tests and power tests, for recovery across a cyclic week of competitive rugby union                                   |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 23 | Hohenauer<br>et al 2019   | Partial body cryotherapy (-135) and CWI (10) after muscle damage in females   |                                   |                                    |                           |                                     |                                 |                         |                        | 2                         |                        |                                      | +                              |
| 24 | Howatson et<br>al 2009    | The influence of CWI on adaptation following a single bout of damaging exercises  |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 25 | Ingram et al<br>2009      | Effect of water immersion methods on post-exercise recovery from simulated team sport exercise  |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 26 | Jajtner et al<br>2015     | Comparison of the effects of electrical stimulation and CWI on muscle soreness after resistance exercises   |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 27 | Jakeman et al<br>2009     | A single 10min bout of CWI therapy after strenuous plyometric exercise has no beneficial effect on recovery from the symptoms of exercise-induced muscle damage |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 28 | Jones et al<br>2013       | The effects of different recovery interventions following a repeated rugby union (sevens) game simulated protocol   |                                   |                                    |                           |                                     |                                 |                         |                        | 2                         |                        |                                      | +                              |
| 29 | Lane et al<br>2004        | Effect of selected recovery conditions on performance of repeated bouts of intermittent cycling separated by 24 hours   |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 30 | Leeder et al<br>2015      | Effects of seated and standing CWI on recovery from repeated sprinting  |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | ++                             |
| 31 | Leeder et al<br>2019      | CWI improves recovery of sprint speed following a simulated tournament  |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |

| #  | Author,<br>Year             | Title   | <u>1.1</u><br>focused<br>question | <u>1.2</u><br>randomised<br>groups | <u>1.3</u><br>concealment | <u>1.4</u><br>blinded<br>allocation | <u>1.5</u><br>similar<br>groups | <u>1.6</u><br>treatment | <u>1.7</u><br>outcomes | <u>1.8</u><br>drop<br>out | <u>1.9</u><br>analysis | <u>1.10</u><br>comparable<br>results | <u>2.1</u><br>Final<br>Ranking |
|----|-----------------------------|---|-----------------------------------|------------------------------------|---------------------------|-------------------------------------|---------------------------------|-------------------------|------------------------|---------------------------|------------------------|--------------------------------------|--------------------------------|
| 32 | Lindsay et al<br>2017       | The physiological response to CWI following mixed martial arts training session                                       |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | ++                             |
| 33 | Machado et al<br>2017       | Dosages of CWI post exercise on functional and clinical responses   |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | ++                             |
| 34 | Minett et al<br>2014        | CWI decreases cerebral oxygenation but improves recovery after intermittent sprint exercise in the heat               |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 35 | Missau et al<br>2018        | CWI and inflammatory response after resistance exercises  |                                   |                                    |                           |                                     |                                 |                         |                        | 2                         |                        |                                      | ++                             |
| 36 | Moriera et al<br>2015       | CWI did not accelerate recovery after a futsal match  |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 37 | Paddon-Jones et al<br>1997  | Effect of cryotherapy on muscle soreness and strength following eccentric exercise                                    |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 38 | Pointon et al<br>2012       | CWI recovery after simulated collision sport exercise   |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 39 | Pournot et al<br>2011       | Short term effects of various water immersions on recovery from exhaustive intermittent exercise                      |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 40 | Rose et al<br>2014          | Does WBC improve muscle recovery after damaging eccentric exercise?   |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 41 | Rupp et al<br>2012          | The effect of CWI on 48h performance testing in collegiate soccer players   |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | +                              |
| 42 | Sanchez-Urena et al<br>2018 | Effectiveness of 2 CWI protocols on neuromuscular function recovery: a tensiomyography study                          |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | ++                             |
| 43 | Siqueira et al<br>2018      | Multiple CWI attenuate muscle damage but not alter systemic inflammation and muscle function recovery: a parallel RCT |                                   |                                    |                           |                                     |                                 |                         |                        | 1                         |                        |                                      | +                              |
| 44 | Stenson et al<br>2017       | 5000m run performance is not enhanced 24hrs after an intense exercise bout and CWI                                    |                                   |                                    |                           |                                     |                                 |                         |                        | 0                         |                        |                                      | -                              |

| #  | <u>Author,<br/>Year</u> | <u>Title</u>  | <u>1.1<br/>focused<br/>question</u> | <u>1.2<br/>randomised<br/>groups</u> | <u>1.3<br/>concealment</u> | <u>1.4<br/>blinded<br/>allocation</u> | <u>1.5<br/>similar<br/>groups</u> | <u>1.6<br/>treatment</u> | <u>1.7<br/>outcomes</u> | <u>1.8<br/>drop<br/>out</u> | <u>1.9<br/>analysis</u> | <u>1.10<br/>comparable<br/>results</u> | <u>2.1<br/>Final<br/>Ranking</u> |
|----|-------------------------|---|-------------------------------------|--------------------------------------|----------------------------|---------------------------------------|-----------------------------------|--------------------------|-------------------------|-----------------------------|-------------------------|--|----------------------------------|
| 45 | Tabben et al 2018       | CWI enhanced athletes wellness and 10m short sprint performance 24h after a simulated mixed martial arts combat                           |                                     |                                      |                            |                                       |                                   |                          |                         | 0                           |                         |  | +                                |
| 46 | Takeda et al 2014       | The effects of CWI after rugby training on muscle power and biochemical markers   |                                     |                                      |                            |                                       |                                   |                          |                         | 0                           |                         |  | +                                |
| 47 | Vaile et al 2008 (1)    | Effect of hydrotherapy on recovery from fatigue   |                                     |                                      |                            |                                       |                                   |                          |                         | 0                           |                         |  | +                                |
| 48 | Vaile et al 2008 (2)    | Effect of hydrotherapy on the signs and symptoms of DOMS  |                                     |                                      |                            |                                       |                                   |                          |                         | 0                           |                         |  | +                                |
| 49 | Vanderlei et al 2017    | Post exercise recovery of biological, clinical and metabolic variables after different temperatures and durations of CWI: a RCT           |                                     |                                      |                            |                                       |                                   |                          |                         | 6                           |                         |  | ++                               |
| 50 | Vieira et al 2016       | The effect of water temperature during CWI on recovery from exercise induced muscle damage  |                                     |                                      |                            |                                       |                                   |                          |                         | 0                           |                         |  | ++                               |
| 51 | White et al 2014        | The effect of various CWI protocols on exercise induced inflammatory response and functional recovery from high intensity sprint exercise |                                     |                                      |                            |                                       |                                   |                          |                         | 0                           |                         |  | ++                               |
| 52 | Wiewelhove et al 2018   | Effects of different recovery strategies following a half marathon on fatigue markers in recreational runners                             |                                     |                                      |                            |                                       |                                   |                          |                         | 0                           |                         |  | -                                |