# 冰水浴與肌肉適應

111年教練增能教育訓練系列課程

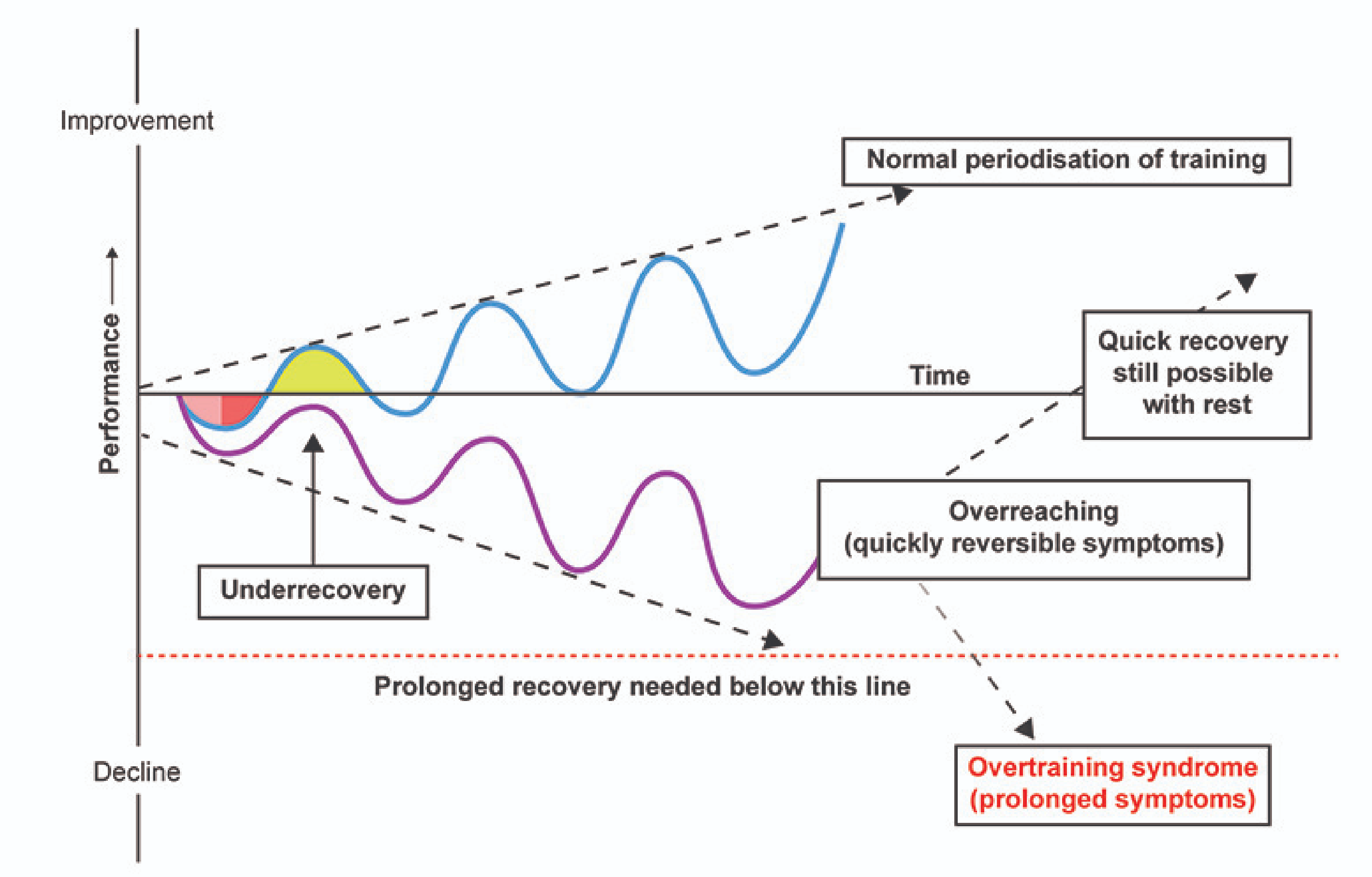
2022/12/07

運動科學處
陸康豪

# 110年度教練增能課程

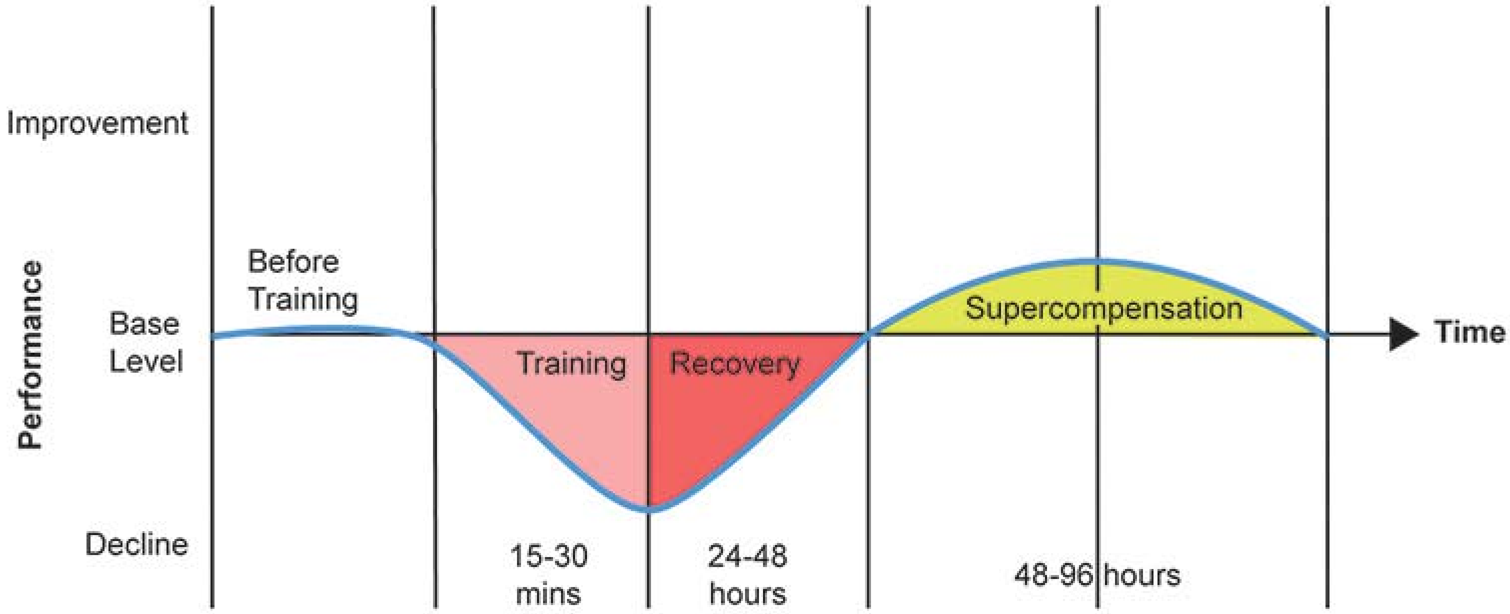
- 基礎課程
  - 阻力訓練與神經、肌肉適應 (110/11/13)
  - 有氧/無氧訓練與循環、代謝系統
  - 停止訓練之影響
- 實務議題
  - 冰水浴與肌肉適應
  - 抗氧化劑與訓練適應

# Underrecovery



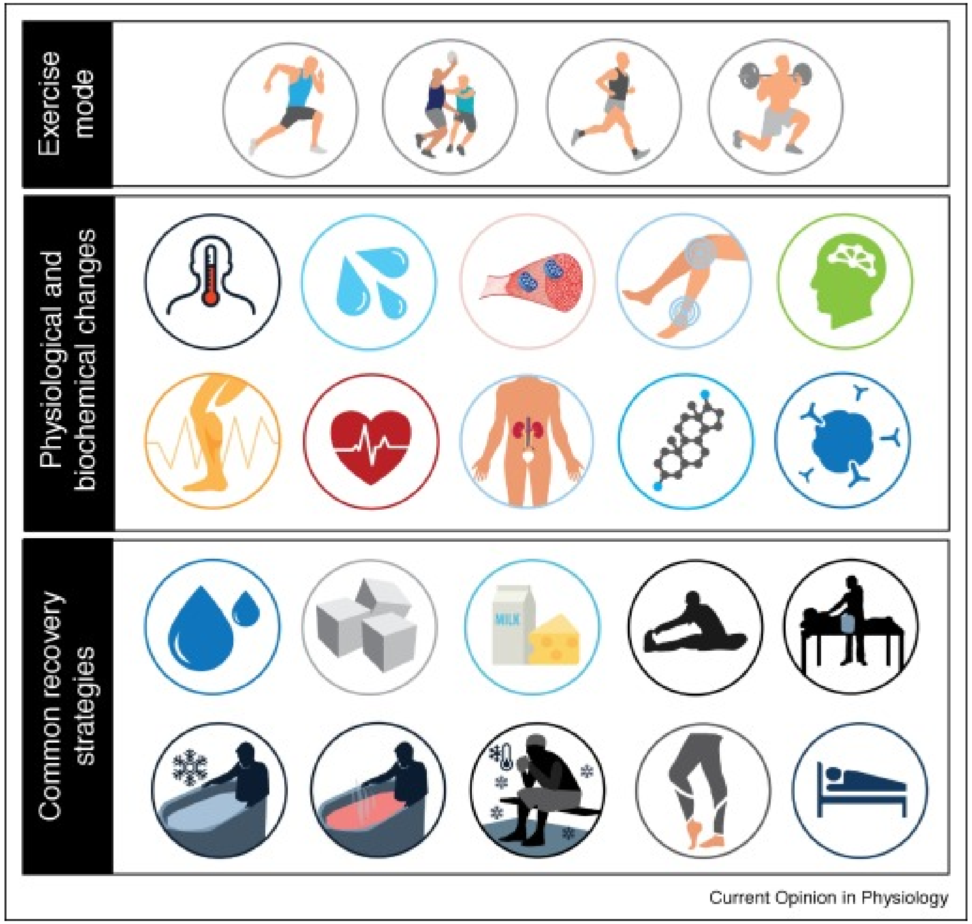

https://www.open.edu/openlearn/mod/oucontent/view.php?id=85414&extra=thumbnailfigure_idm211

# Supercompensation




https://www.open.edu/openlearn/mod/oucontent/view.php?id=85414&extra=thumbnailfigure_idm197

# Recovery




https://www.sciencedirect.com/science/article/abs/pii/S2468867319300379

# Hydrotherapy

- 冰水浴 (CWI)
- 對比浴 (CWT)
- 熱水浴 (HWI)


https://www.dailymail.co.uk/sport/olympics/article-2178793/London-2012-British-track-field-stars-make-final-Olympic-preparations-Portugal.html

https://www.menshealth.com/fitness/a26788252/ice-bath-benefits/

# Hydrotherapy

- 冰水浴 (CWI)
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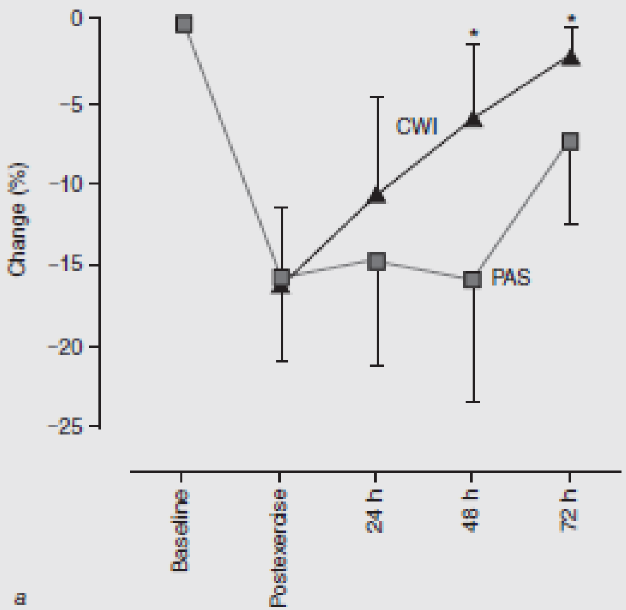
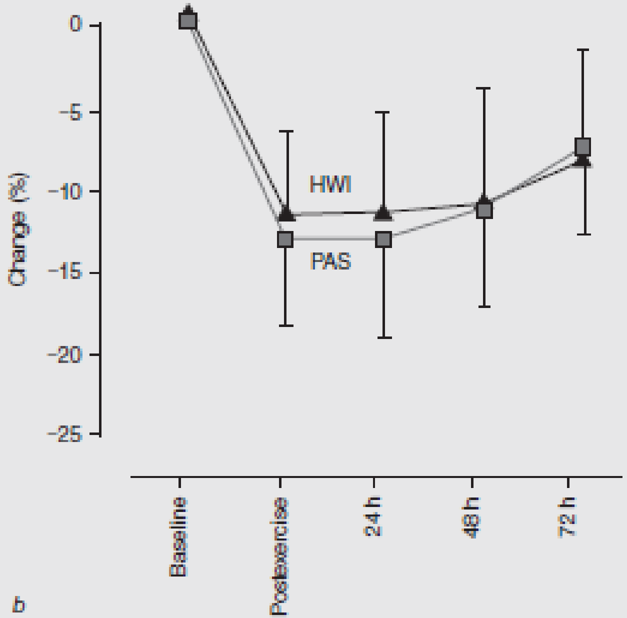
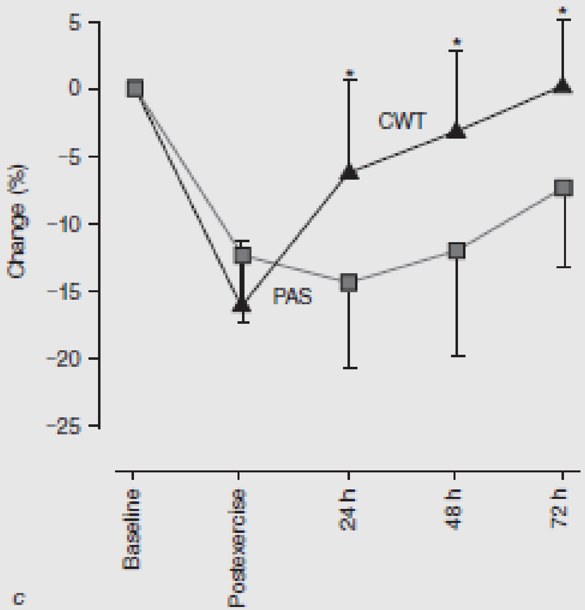
($n$ = 12), (2) hot water immersion ($n$ = 11), or (3) contrast water therapy ($n$ = 15) (Vaile et al. 2008a) (figure 10.1). For each trial, participants performed a DOMS-inducing leg press protocol followed by either passive recovery or one of the hydrotherapy interventions for a total of 14 min. Performance was assessed via weighted squat jump and isometric squat; perceived pain, thigh girths, and blood variables were measured prior to exercise, immediately afterward, and at 24, 48, and 72 h postexercise. Overall, cold water immersion and contrast water therapy were found to be effective in reducing the physiological and functional deficits associated with DOMS, including improved recovery of isometric force and dynamic power and a reduction in localized edema (Vaile et al. 2008a). Although hot water immersion was effective in the recovery of isometric force, it was ineffective for recovery of all other markers compared with passive recovery.




AIS. (2013). *Physiological tests for elite athletes* (2nd ed.) (p. 154).

# Cold water immersion

- 一般療程
  - 浸泡四肢或軀幹
  - 5-20 min
  - 8-15 ℃
  - 連續vs. 間歇
    - Ex: 3 bouts of 4 min with 30 s resting
- 恢復效益
  - 肌力
  - 肌肉痠痛
  - 自覺疲勞
  - 發炎反應
  - 肌肉損傷
  - 痙攣與疼痛
  - 向心血流
  - 腫脹

Peake (2020). *The Journal of Physiology.*
Petersen et al. (2021). *Front. Sports Act. Living.*

# Yamane et al. (2006)

> Eur J Appl Physiol. 2006 Mar;96(5):572-80. doi: 10.1007/s00421-005-0095-3. Epub 2005 Dec 22.

FULL TEXT LINKS

SpringerLink FULL-TEXT ARTICLE

## Post-exercise leg and forearm flexor muscle cooling in humans attenuates endurance and resistance training effects on muscle performance and on circulatory adaptation

Motoi Yamane [1], Hiroyasu Teruya, Masataka Nakano, Ryuji Ogai, Norikazu Ohnishi, Mitsuo Kosaka

Affiliations + expand

PMID: 16372177 DOI: 10.1007/s00421-005-0095-3

ACTIONS

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### Abstract

The influence of regular post-exercise cold application to exercised muscles trained by ergometer cycling (leg muscles) or handgrip exercise using a weight-loaded handgrip ergometer (forearm flexor muscles) was studied in human volunteers. Muscle loads were applied during exercise programs three to four times a week for 4-6 weeks. Besides measuring parameters characterizing muscle performance, femoral and brachial artery diameters were determined ultrasonographically. Training effects were identified by comparing pre- and post-training parameters in matched groups separately for the trained limbs cooled after exercise by cold-water immersion and the corresponding trained limbs kept at room temperature. Significant training effects were three times more frequent in the

PAGE NAVIGATION

Title & authors

Abstract

Similar articles

# Yamane et al. (2006)

- Study design
  - CWI: 20 min at 10 ± 1℃
  - CON: Non-immersion at 25 ± 1℃
- Exercises trained
  - Wrist flexion exercise
  - 4 weeks
  - 3 x / week
  - 3 × 8-RM
- Maximal strength
  - Greater ↑ for control vs. CWI group
- Strength endurance
  - ↑ Number of for control group, but ↔ for CWI group

Petersen et al. (2021). *Front. Sports Act. Living.*

# Ohnishi et al. (2004)

Access through your institution | Purchase PDF

Journal of Thermal Biology

Volume 29, Issues 7–8, October–December 2004, Pages 839-843

ELSEVIER

Adaptive changes in muscular performance and circulation by resistance training with regular cold application

N. Ohnishi [a], M. Yamane [b], N. Uchiyama [a], S. Shirasawa [a], M. Kosaka [b], H. Shiono [c], T. Okada [c]

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https://doi.org/10.1016/j.jtherbio.2004.08.069   Get rights and content

- Exercises trained
  - 6 weeks
  - Handgrip exercise
- Strength endurance
  - ↑ Number of for both control and CWI groups
  - No difference between groups

# 研究結果矛盾

- 某因子對某變項之影響
  - 有、無統計顯著差異

| 研究 | 統計結果 |
|---|---|
| A | 顯著差異 |
| B | 無差異 |
| C | 顯著差異 |
| D | 顯著差異 |
| E | 無差異 |

# 研究結果矛盾

- 某因子對某變項之影響
  - 效果量大、中、小

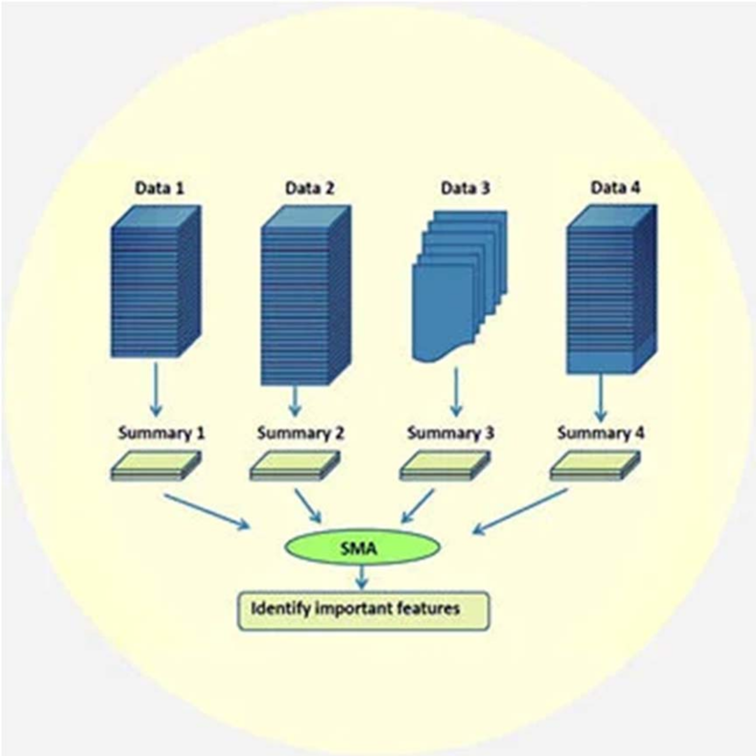
| 研究 | 統計結果 | 效果量 |
|---|---|---|
| A | 顯著差異 | 中 |
| B | 無差異 | 小 |
| C | 顯著差異 | 大 |
| D | 顯著差異 | 小 |
| E | 無差異 | 小 |

# 研究結果矛盾

- 某因子對某變項之影響
  - 樣本數多寡

| 研究 | 統計結果 | 效果量 | 樣本數 |
|---|---|---|---|
| A | 顯著差異 | 中 | 20 |
| B | 無差異 | 小 | 30 |
| C | 顯著差異 | 大 | 20 |
| D | 顯著差異 | 小 | 40 |
| E | 無差異 | 小 | 60 |

# Meta-analysis




- 統合分析
  - 搜尋相似主題研究
  - 計算整體的效果量與信賴區間，依各實驗的效果量、樣本大小進行加權或重組
  - 判定整體效果量是否達到統計顯著差異

https://www.dictionary.com/e/tech-science/meta-analysis/

# Malta et al. (2021)

Sports Medicine (2021) 51:161–174
https://doi.org/10.1007/s40279-020-01362-0

SYSTEMATIC REVIEW

Check for updates

## The Effects of Regular Cold-Water Immersion Use on Training-Induced Changes in Strength and Endurance Performance: A Systematic Review with Meta-Analysis

Elvis S. Malta[1] · Yago M. Dutra[1] · James R. Broatch[2,3] · David J. Bishop[2] · Alessandro M. Zagatto[1]

Published online: 4 November 2020


**Abstract**
**Background** Cold-water immersion (CWI) is one of the main recovery methods used in sports, and is commonly utilized as a means to expedite the recovery of performance during periods of exercise training. In recent decades, there have been indications that regular CWI use is potentially harmful to resistance training adaptations, and, conversely, potentially ben-

# Methods

- The restrictions on language (i.e., articles published in English language only) was adopted.
- The selected studies were clinical controlled studies.
- Books, theses, dissertations, reviews, and conference papers were excluded.

# Methods

- The criteria for inclusion of studies:
  - (1) being a controlled investigation
  - (2) conducted with healthy humans
  - (3) with CWI performed at ≤ 15 °C (after training sessions)

# Methods

- The criteria for inclusion of studies:
  - (4) being associated with a regular training program (≥ 3 weeks)
  - (5) having performed baseline and post-training assessments of strength or aerobic exercise performance

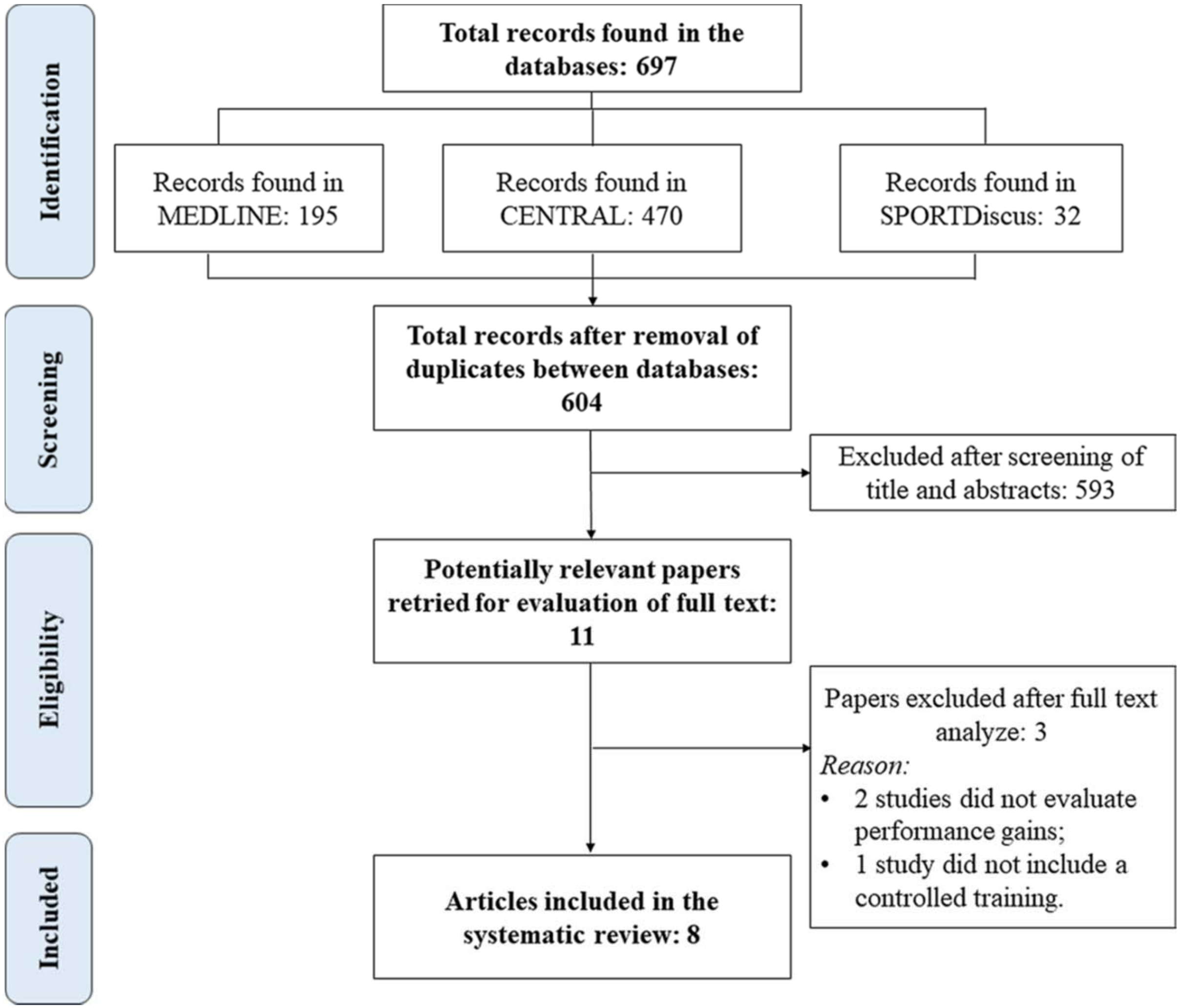
# Data Extraction

- Strength performance
  - One-repetition maximum (1RM)
  - Maximal isometric strength
  - Strength endurance (number of lifts)
  - Ballistic efforts (force measured during jump performance and rate of force development)

# Data Extraction

- Aerobic exercise performance
  - Time-trial duration
  - Mean power in a time-trial
  - Maximal aerobic power (MAP) in a graded exercise test

# Results


Identification
Screening
Eligibility
Included
Total records found in the databases: 697
Records found in MEDLINE: 195
Records found in CENTRAL: 470
Records found in SPORTDiscus: 32
Total records after removal of duplicates between databases: 604
Excluded after screening of title and abstracts: 593
Potentially relevant papers retried for evaluation of full text: 11
Papers excluded after full text analyze: 3
Reason:
• 2 studies did not evaluate performance gains;
• 1 study did not include a controlled training.
Articles included in the systematic review: 8

# Results

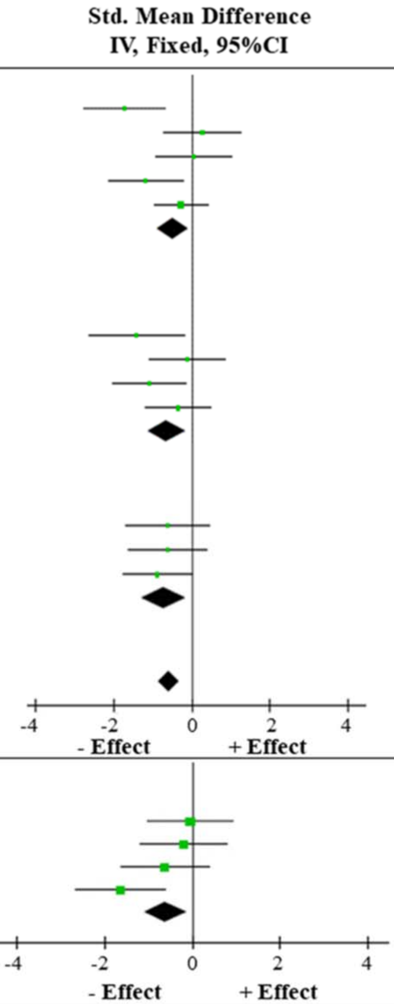
- Among the eight articles selected for the present study:
  - Brazil x 1
  - Australia x 4
  - Japan x 2
  - Germany x 1
- All were published between the years 2006 and 2019.

# Results

- Study volunteers
  - Trained
  - Physically active
  - Recreationally active
  - Sedentary
- Total number including CWI and control groups = 470 volunteers

# Strength performance

| Study or Subgroup | Weighting | Std. Mean Difference IV, Fixed, 95%CI |
|---|---|---|
| **1RM (kg)** | | |
| Roberts et al. [23] (Knee extension) | 6.9 % | -1.73 [-2.77; -0.70] |
| Fyfe et al. [24] (Bench press) | 7.6 % | 0.28 [-0.71; -0.70] |
| Fyfe et al. [24] (Leg press) | 7.7 % | 0.06 [-0.92; 1.04] |
| Roberts et al. [23] (Leg press) | 7.9 % | -1.17 [-2.14; -0.21] |
| Frohlich et al. [5] (Knee extension) | 16.1 % | -0.27 [-0.95; 0.40] |
| **Subtotal (95% CI)** | **46.1 %** | **-0.50 [-0.90, -0.10]** |
| Test for overall effect: Z = 2.45 (P = 0.01) | | |
| **Maximal isometric strength (kg)** | | |
| Yamane et al. [36] (Wrist-flexion) | 5.0 % | -1.41 [-2.63; -0.20] |
| Yamane et al. [28] (Wrist-flexion; part-IV) | 7.6 % | -0.12 [-1.10; 0.86] |
| Roberts et al. [23] (Knee extension) | 8.1 % | -1.09 [-2.04; -0.13] |
| Yamane et al. [28] (Wrist-flexion; part-III) | 10.3 % | -0.34 [-1.19; 0.50] |
| **Subtotal (95% CI)** | **31.0 %** | **-0.65 [-1.14; -0.17]** |
| Test for overall effect: Z = 2.63 (P = 0.009) | | |
| **Strength endurance (n. Lifts)** | | |
| Yamane et al. [36] ] (Wrist-flexion) | 6.3 % | -0.62 [-1.70; 0.46] |
| Yamane et al. [28] ] (Wrist-flexion; part-IV) | 7.2 % | -0.62 [-1.63; 0.39] |
| Yamane et al. [28] ] (Wrist-flexion; part-III) | 9.4 % | -0.88 [-1.76; 0.01] |
| **Subtotal (95% CI)** | **22.9 %** | **-0.73 [-1.29; -0.16]** |
| Test for overall effect: Z = 2.51 (P = 0.01) | | |
| **Total (95% CI)** | **100.0 %** | **-0.60 [-0.87; -0.33]** |
| Test for overall effect: Z = 4.33 (P < 0.0001) | | |
| **Ballistic efforts (N and Nm·s$^{-1}$)** | | |
| Fyfe et al. [24] (Ballistic push-up) | 25.9 % | -0.04 [-1.02; 0.94] |
| Fyfe et al. [24] (CMJ) | 25.7 % | -0.21 [-1.19; 0.78] |
| Fyfe et al. [24] (SJ) | 24.4% | -0.62 [-1.63; 0.39] |
| Roberts et al. [23] (Knee extension) | 24.0% | -1.65 [-2.66; -0.63] |
| **Total (95% CI)** | **100.0 %** | **-0.61 [-1.11; -0.11]** |
| Test for overall effect: Z = 2.40 (P = 0.02) | | |



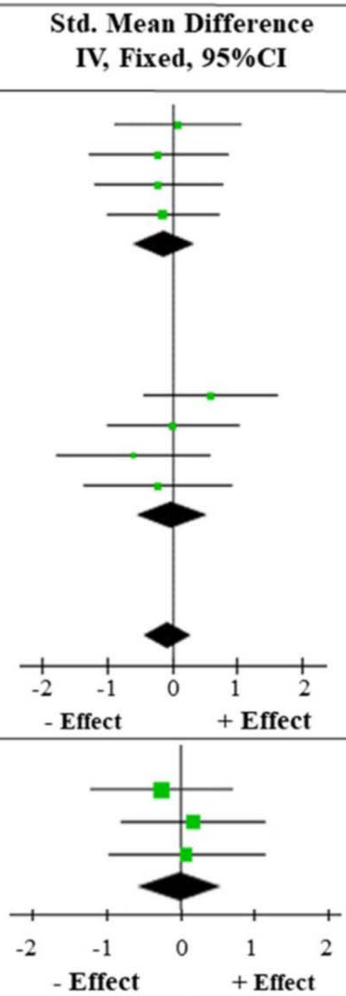
# Cohen's d

| Relative size | Effect size | % of control group below the mean of experimental group |
|---|---|---|
| | 0.0 | 50% |
| Small | 0.2 | 58% |
| Medium | 0.5 | 69% |
| Large | 0.8 | 79% |
| | 1.4 | 92% |

https://www.simplypsychology.org/effect-size.html

# Aerobic exercise performance

| Study or Subgroup | Weighting | Std. Mean Difference IV, Fixed, 95%CI |
|---|---|---|
| **Time-trial mean power (W)** | | |
| Aguiar et al. [21] (15 km) | 14.1 % | 0.08 [-0.87; 1.04] |
| Broatch et al. [4] (20 km) | 11.3 % | -0.22 [-1.28; 0.84] |
| Broatch et al. [4] (2 km) | 13.2 % | -0.21[-1.19; 0.77] |
| Halson et al., [27] (10 min) | 17.4 % | -0.15 [-1.00; 0.71] |
| **Subtotal (95% CI)** | **56.0 %** | **-0.12 [-0.60; 0.36]** |
| Test for overall effect: Z = 0.48 (P = 0.63) | | |
| **MAP in Graded exercise test (W)** | | |
| Aguiar et al. [21] (incremental test) | 12.4 % | 0.59 [-0.42; 1.61] |
| Broatch et al. [4] (incremental test) | 12.4 % | 0.01 [-1.00; 1.03] |
| Yamane et al. [28] (incremental test; part-I) | 9.4 % | -0.60 [-1.77; 0.57] |
| Yamane et al. [28] (incremental test; part-II) | 9.9 % | -0.22 [-1.36; 0.92] |
| **Subtotal (95% CI)** | **44.0 %** | **-0.01 [-0.54; 0.53]** |
| Test for overall effect: Z = 0.02 (P = 0.98) | | |
| **Total (95% CI)** | **100.0 %** | **-0.07 [-0.54; 0.53]** |
| Test for overall effect: Z = 0.38 (P = 0.71) | | |
| **Time-trial performance (s)** | | |
| Aguiar et al. [21] (15 km) | 36.2 % | -0.25 [-1.21; 0.71] |
| Broatch et al. [4] (2 km) | 34.3 % | 0.19 [-0.80; 1.17] |
| Broatch et al. [4] (20 km) | 29.5 % | 0.09 [-0.97; 1.15] |
| **Total (95% CI)** | **100.0 %** | **0.00 [-0.58; 0.58]** |
| Test for overall effect: Z = 0.00 (P = 1.00) | | |



# Conclusions

- The regular use of CWI associated with exercise programs has a deleterious effect on resistance training adaptations but does not appear to affect aerobic exercise performance.

# 本土研究

運動生理暨體能學報　30輯，9-19頁 (2020年6月)
Journal of Exercise Physiology and Fitness　Vol.30, pp. 9-19 (June, 2020)
DOI:10.6127/JEPF.202006_(30).0002



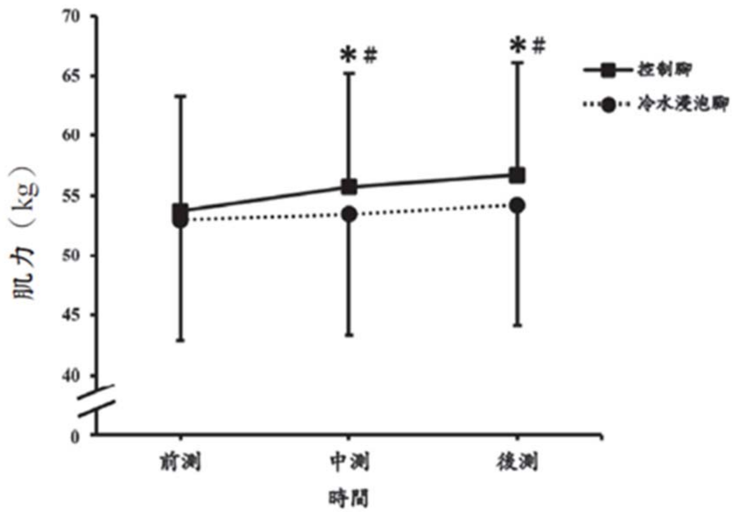
## 六週高強度間歇訓練後冷水浸泡介入對下肢肌力及肌耐力表現之影響

王為新、蔡易珊、鄭皓謙、王鶴森*

### 摘要

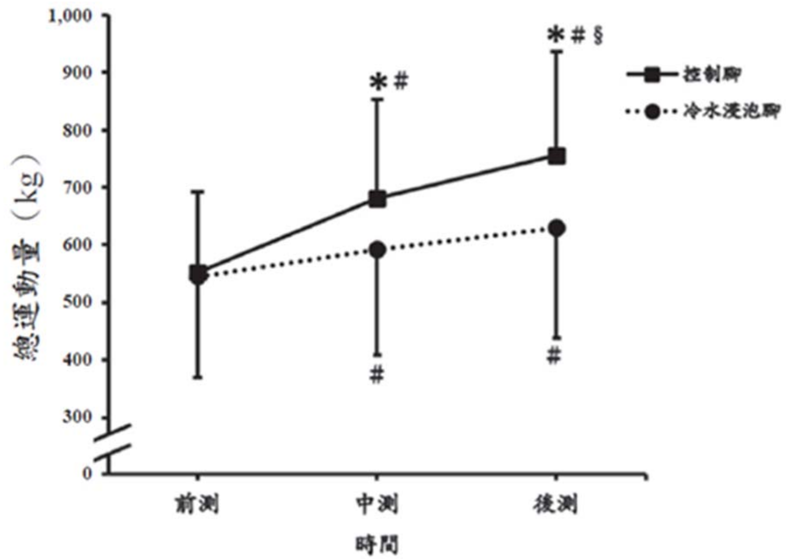
**目的**：阻力訓練後實施冷水浸泡雖降低遲發性肌肉痠痛，但可能會降低肌肉合成及抑制肌力表現的增進，故本研究目的在探討高強度間歇訓練後進行冷水浸泡，對下肢肌力表現是否亦有負面影響。**方法**：受試者為10名體育系男性（年齡：23.2 ± 2.7歲），於跑步機上進行為期6週，每週2次（共12次）的高強度間歇跑步訓練，每次訓練強度為90～95%最大心跳率（maximal heart rate, $HR_{max}$）持續4分鐘，主動恢復為70% $HR_{max}$持續3分鐘，共4組循環。所有受試者並依隨機分派方式將其下肢分為冷水浸泡腳及控制腳，於每次訓練後冷水浸泡腳進行10分鐘10°C的

# 本土研究




圖一　控制腳與冷水浸泡腳進行六週高強度間歇訓練的前、中及後測肌力變化

註：*表示組別之間有顯著差異（$p < .05$）；#表示與前測相比有顯著差異（$p < .05$）。




圖二　控制腳與冷水浸泡腳進行六週高強度間歇訓練的前、中及後測總運動量（肌耐力）變化

註：*表示組別之間有顯著差異（$p < .05$）；#表示與前測相比有顯著差異（$p < .05$）；§表示與中測相比有顯著差異（$p < .05$）。

# Cold water immersion

- CWI
  - ↓ core and tissue temperature
  - local vasoconstriction
  - hydrostatic pressure
- Physiological alterations
  - Decreases in metabolic activity, infiltration of immune cells, and limb blood flow.

Malta et al. (2021). *Sports Medicine.*

# Inflammation

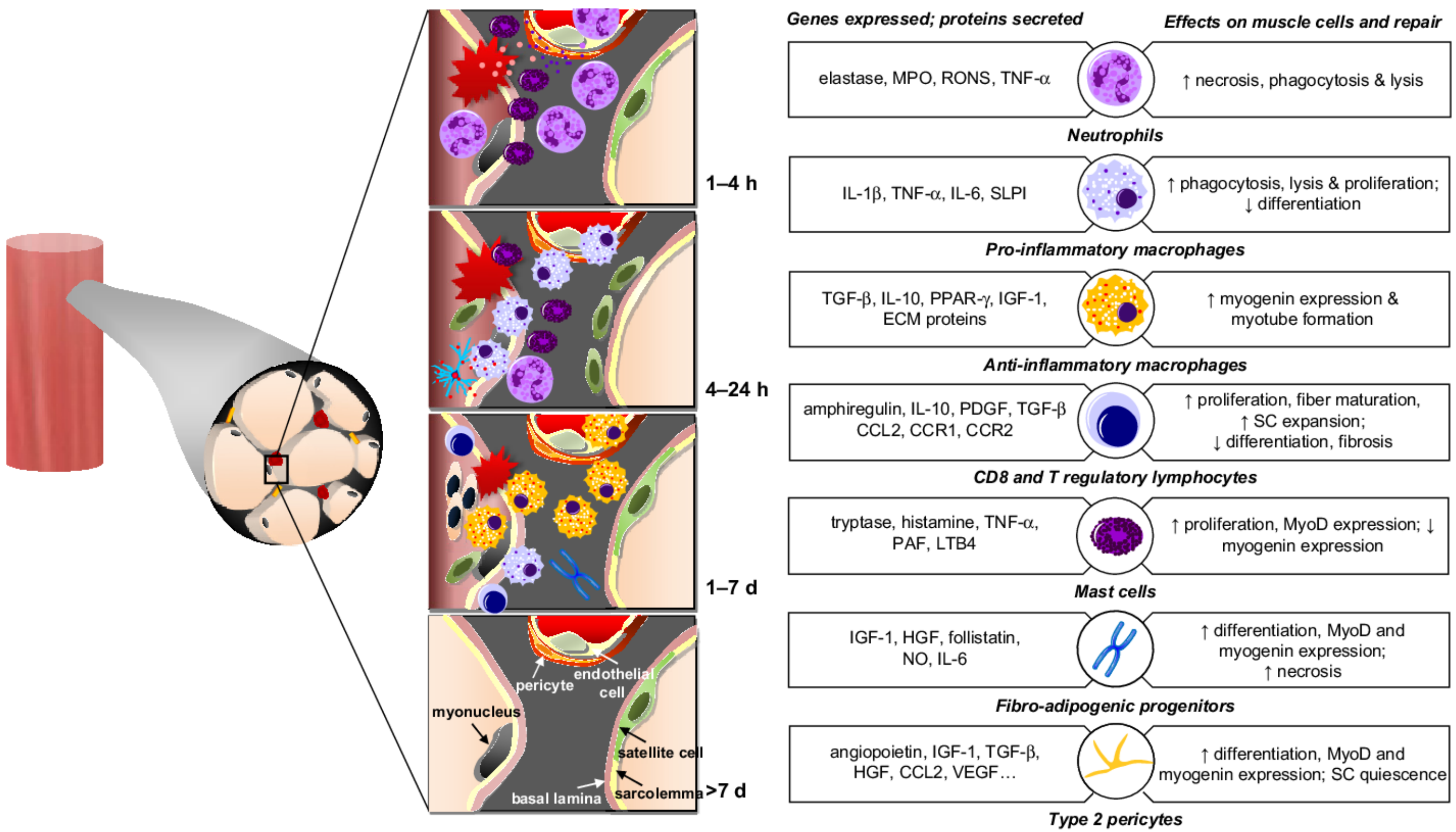
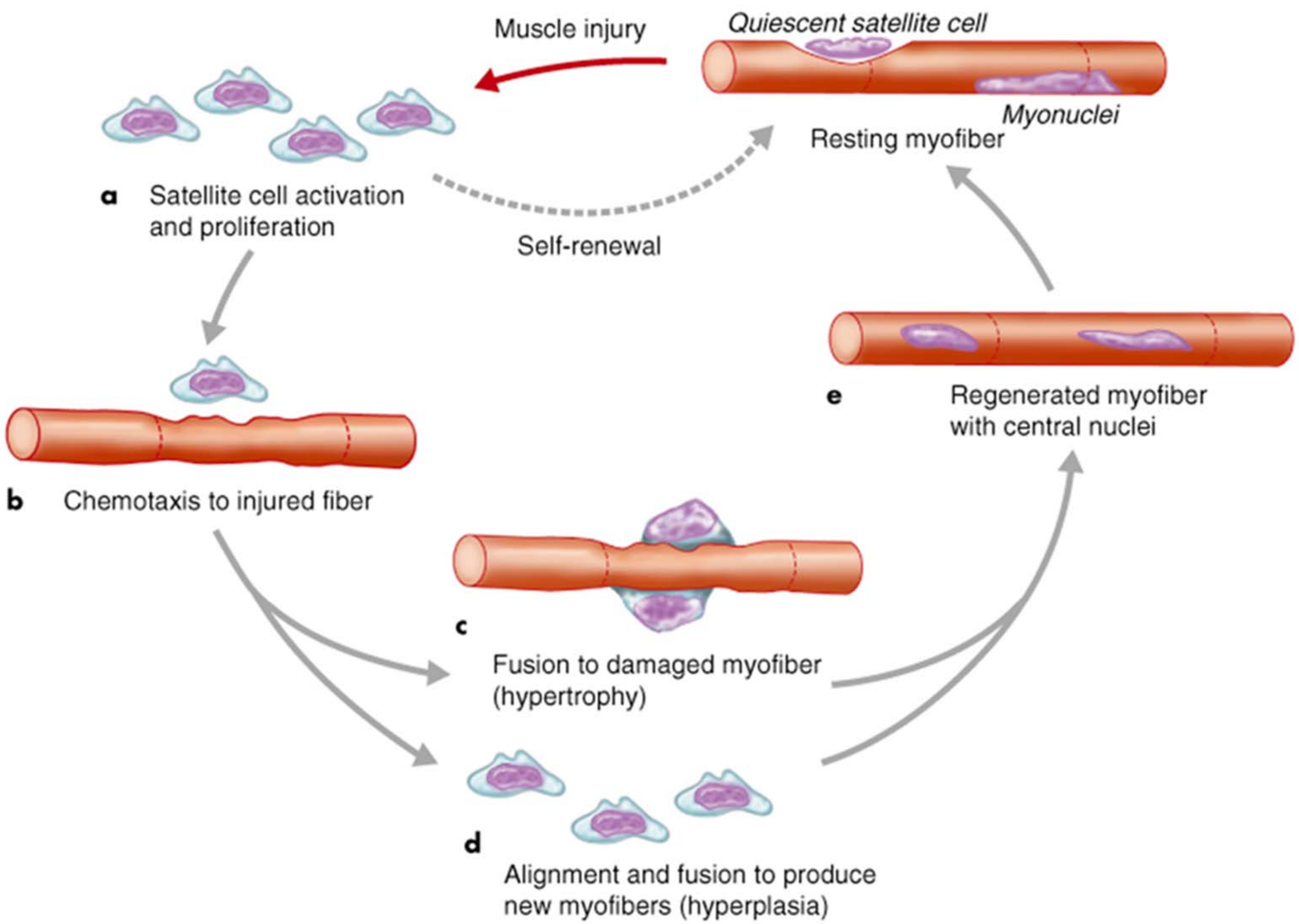



Fig. 1. Graphical illustration of the cell types within skeletal muscle that contribute to muscle immune cell interactions and regulate muscle adaptation following

Peake et al. (2017). *Journal of Applied Physiology.*

# SATELLITE CELL RESPONSE TO INJURY




Wilmore & Costill. *Physiology of sports and exercise.*

# Muscle protein synthesis

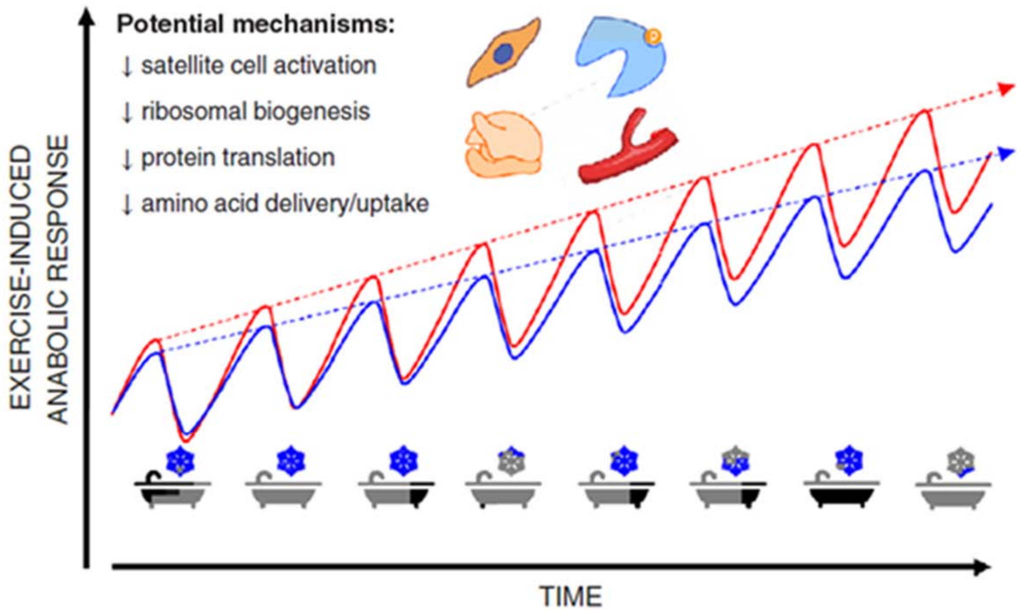
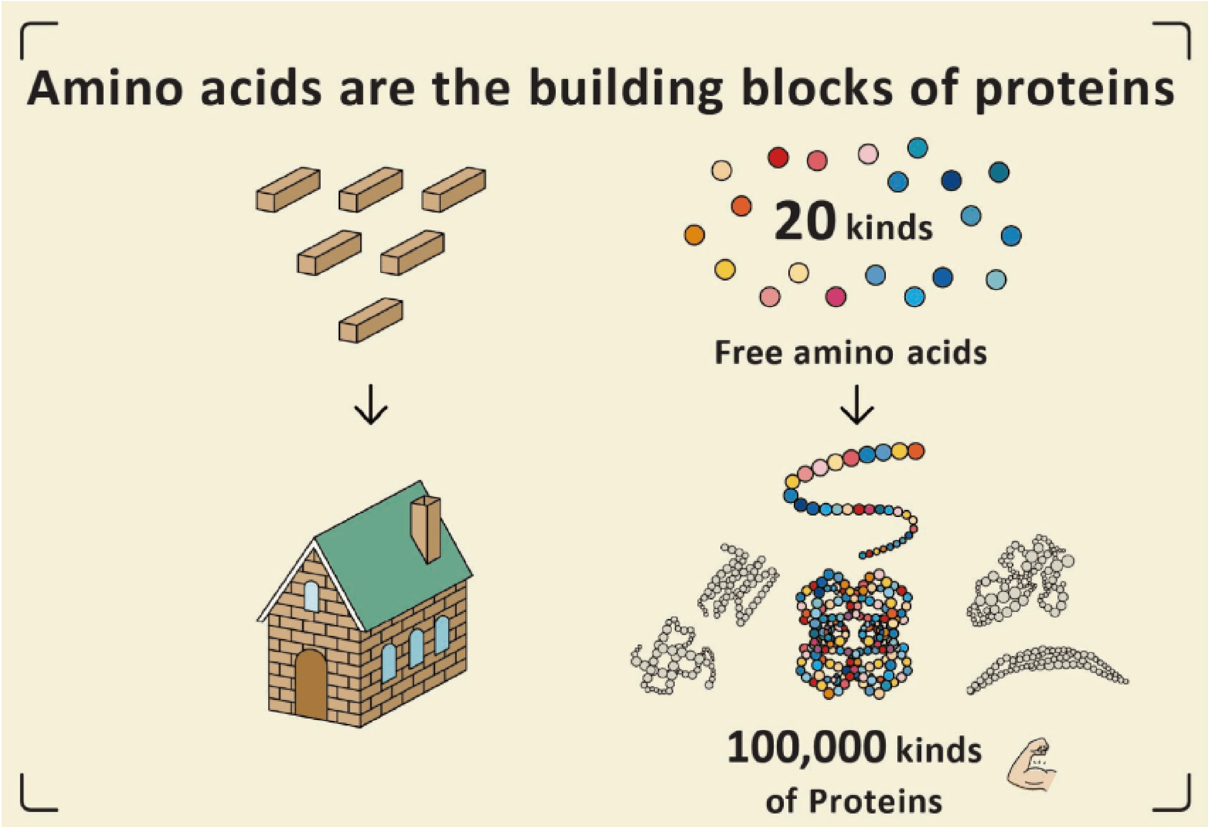



**Figure 1.**
Infographic depicting acute anabolic responses (continuous lines) and the trajectory of long-term gains in muscle mass and strength (dotted lines) to repeated bouts of resistance exercise with (blue lines) or without (red lines) post-exercise cold water immersion.

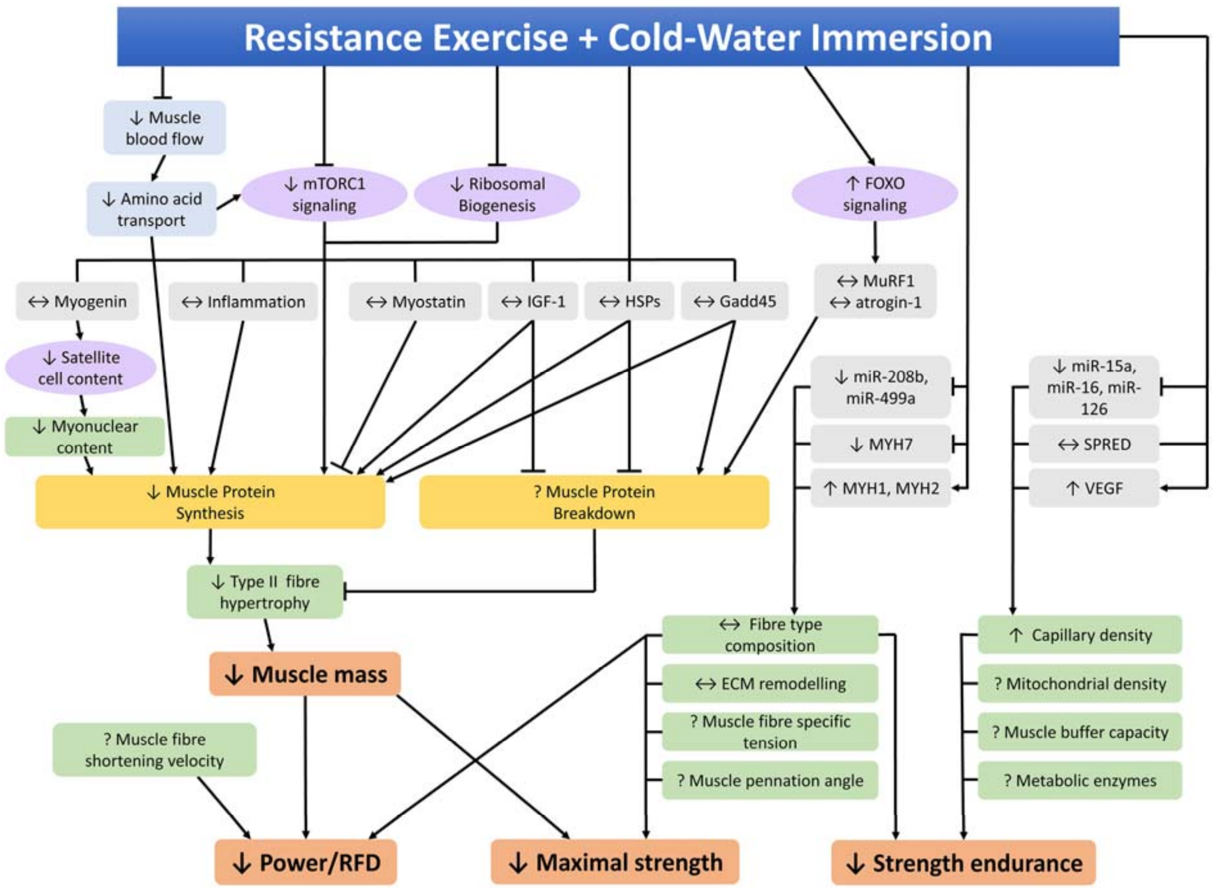
Peake (2020). *The Journal of Physiology.*

# Amino acids




https://www.ajinomoto.com/amino-acids/what-are-amino-acids

# Molecular mechanisms




Petersen et al. (2021). *Front. Sports Act. Living.*

# Peake (2020).

- CWI after exercise suppresses satellite cells and various molecular factors that regulate muscle hypertrophy.

*J Physiol* 598.4 (2020) pp 625–626 625

TRANSLATIONAL PERSPECTIVES

**Independent, corroborating evidence continues to accumulate that post-exercise cooling diminishes muscle adaptations to strength training**

Jonathan M. Peake[1,2]

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Edited by: Scott Powers & Troy Hornberger

more comprehensive studies by several independent research groups has ensued.

Roberts *et al.* conducted a study of physically active young men who performed 3 months of strength training (twice per week) (Roberts *et al.* 2015). After each training session, half of the participants immersed their lower body in water at 10°C for 10 min, while the other participants performed active recovery on a stationary bicycle. Similar to the findings of Yamane *et al.*, regular CWI attenuated gains in muscular strength, but it also reduced improvements in muscle mass. Follow-up studies by the same group on the acute effects of CWI after resistance exercise acutely reduced phosphorylation of rpS6 kinase (another key protein involved in muscle protein synthesis). Over the training period, CWI also decreased the expression of heat shock protein 27, whereas it increased the expression of Forkhead Box O1 protein. These findings therefore provided further evidence that CWI not only blocks mechanisms responsible for anabolic responses in skeletal muscle, but it also appears to induce some catabolic responses.

Although intriguing, the findings of these studies were restricted to upstream factors that regulate muscle protein synthesis in response to resistance training. A key

# Take-home message

- If the goal of exercise training is to build muscle mass and strength, regular CWI after exercise may not be beneficial.
- However, no disadvantage to using CWI when rapid recovery is needed during a taper period, or between games/matches in close succession.

# Whole-Body Cryotherapy

https://michaelkummer.com/health/ice-bath-vs-cryotherapy/

# CWI vs. WBC

- CWI
  - 浸泡四肢或軀幹
  - 5-20 min
  - 8-15 ℃
  - 深層肌肉降溫
    - 肌肉血流量↓
- WBC
  - 肩部以下
  - 60 s x 3 sets
  - 90 s x 2 sets
  - -110 to -140 ℃
  - 表皮短暫降溫/回溫
    - 全身血流量↑

# Mawhinney et al. (2017)

## Cold Water Mediates Greater Reductions in Limb Blood Flow than Whole Body Cryotherapy

Chris Mawhinney [1], David A Low, Helen Jones, Daniel J Green, Joseph T Costello, Warren Gregson

Affiliations + expand

PMID: 28141620 DOI: 10.1249/MSS.0000000000001223

### Abstract

**Purpose:** Cold-water immersion (CWI) and whole body cryotherapy (WBC) are widely used recovery methods in an attempt to limit exercise-induced muscle damage, soreness, and functional deficits after strenuous exercise. The aim of this study was to compare the effects of ecologically valid CWI and WBC protocols on postexercise lower limb thermoregulatory, femoral artery, and cutaneous blood flow responses.

**Methods:** Ten males completed a continuous cycle exercise protocol at 70% maximal oxygen uptake until a rectal temperature of 38°C was attained. Participants were then exposed to lower-body CWI (8°C) for 10 min, or WBC (-110°C) for 2 min, in a randomized crossover design. Rectal and thigh skin, deep, and superficial muscle temperatures, thigh, and calf skin blood flow (laser Doppler flowmetry), superficial femoral artery blood flow (duplex ultrasound), and arterial blood pressure were measured before, and for 40 min post, cooling interventions.

**Results:** Greater reductions in thigh skin (CWI, -5.9°C ± 1.8°C; WBC, 0.2°C ± 0.5°C; $P < 0.001$) and

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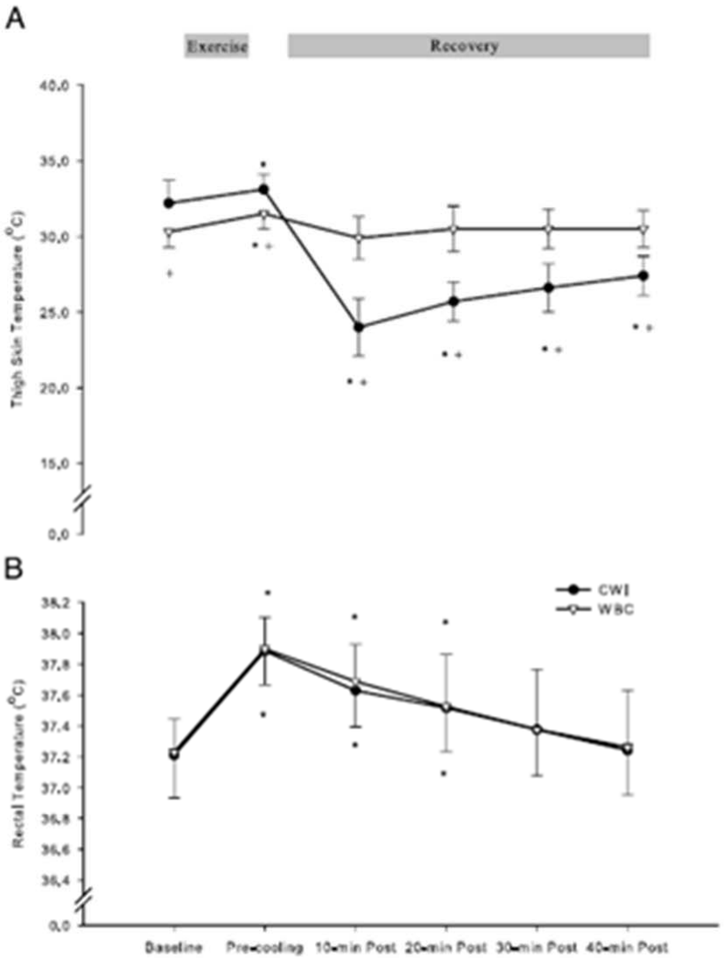
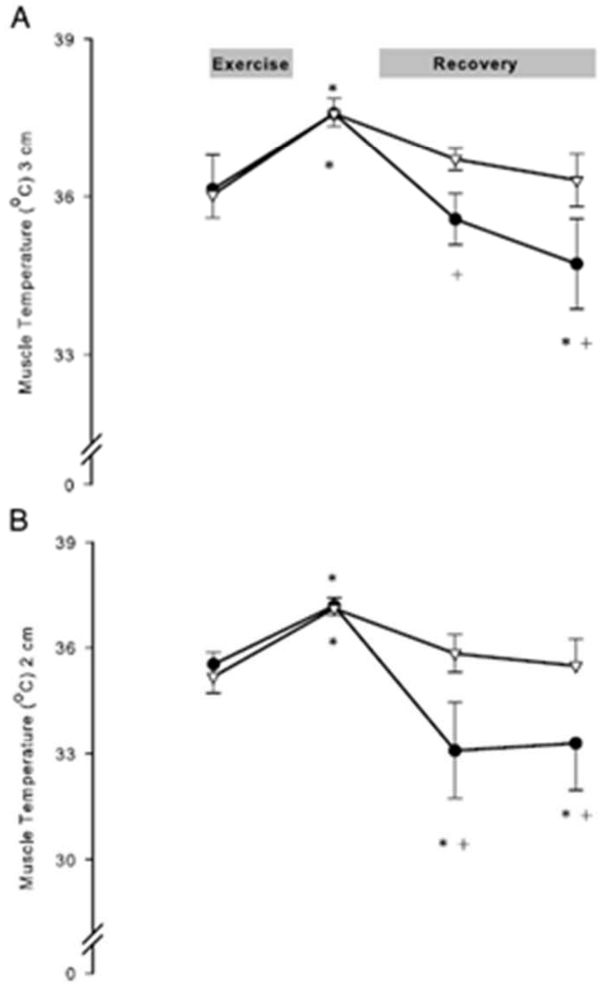



**FIGURE 2**—Thigh skin temperature (A) and rectal temperature (B) pre- and postcooling in CWI and WBC ($n$ = 10, mean ± SD). Main effects for condition ($P$ < 0.001) and time ($P$ < 0.001) alongside a significant interaction between condition and time ($P$ < 0.001) were found for thigh skin temperature. Main effects for time ($P$ < 0.001) and a significant interaction between condition and time ($P$ < 0.001) were found for thigh skin temperature. *Significant difference from baseline ($P$ < 0.05). +Significant difference between cooling conditions ($P$ < 0.05).

## DISCUSSION

The major finding of the present study is that, relative to WBC, CWI led to greater reductions in femoral artery and cutaneous blood flow, as well as deep and superficial muscle temperature, during the postexercise recovery period. Collectively,



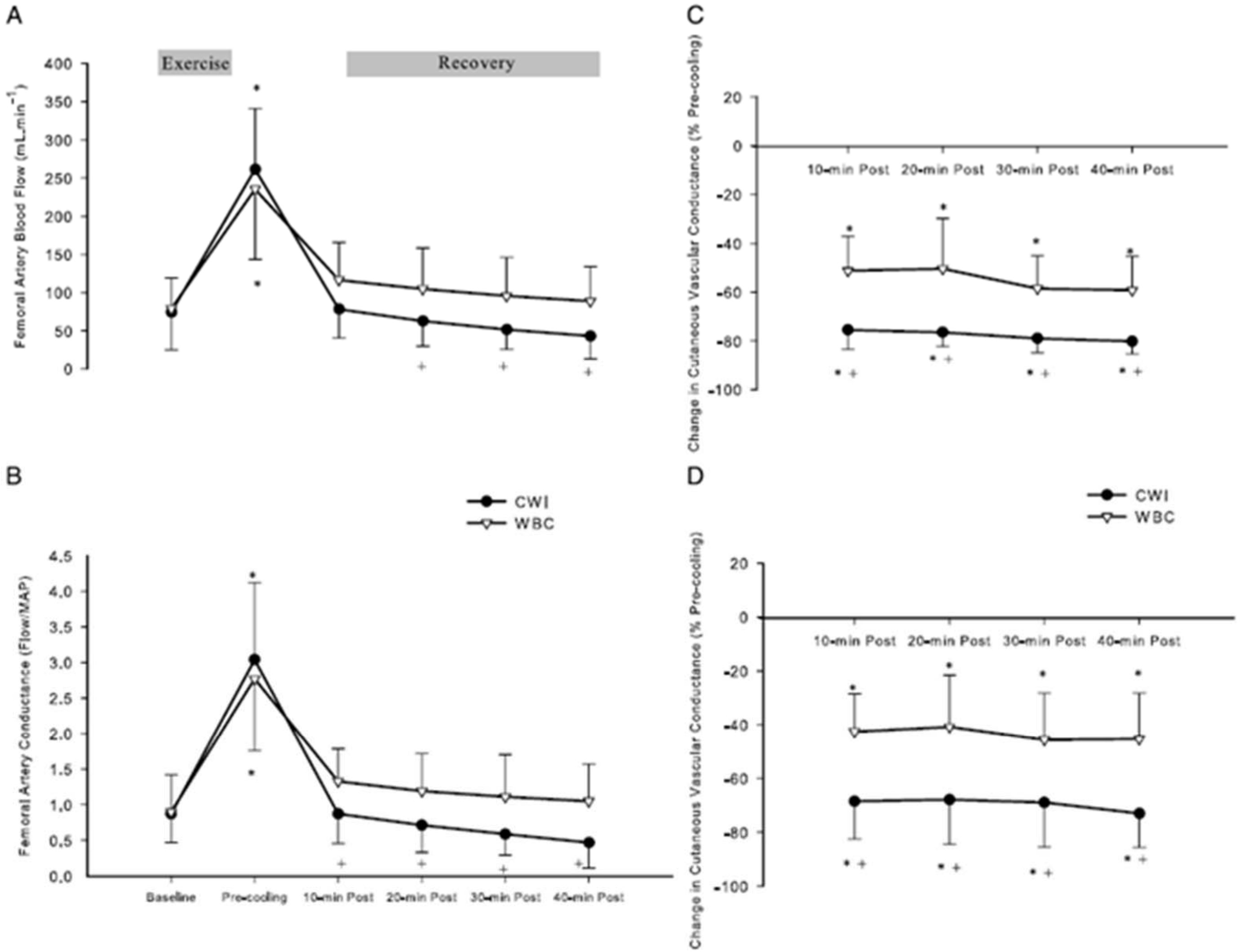
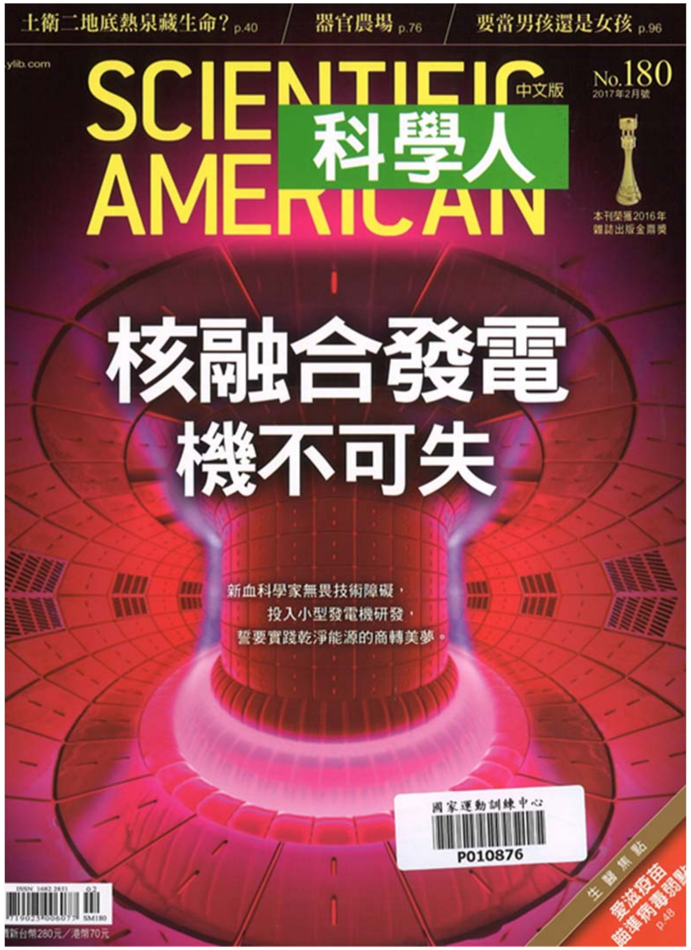



**FIGURE 4**—Femoral artery blood flow (A) and conductance (B) pre- and postcooling in CWI and WBC ($n$ = 10, mean ± SD) and percentage change in thigh cutaneous vascular conductance (C) and calf vascular conductance (D) from preimmersion in CWI and WBC ($n$ = 10, mean ± SD). A main effect for time ($P < 0.001$) alongside a significant interaction between condition and time ($P < 0.01$) was found for both artery flow and conductance. Main effects for condition ($P < 0.001$) were found for both thigh and calf cutaneous vascular conductance. A main effect for time ($P < 0.01$) was also found for thigh conductance. There were no interactions between condition and time in thigh ($P = 0.44$) or calf vascular conductance ($P = 0.52$). *Significant difference from baseline/preimmersion ($P < 0.001$). +Significant difference between cooling conditions (A and B, $P < 0.05$; C and D, $P < 0.001$).

APPLIED SCIENCES

# 科學人2017年2月號




健康與科學
The Science of Health

馬隆（Dina Fine Maron）
美國Scientific American副編輯。

## 冷療法真有效？

令運動員、名流趨之若鶩的冷療法，可能只是安慰劑效應。

撰文／馬隆（Dina Fine Maron）

知名職業橄欖球員馬肯紀（Phil Mackenzie）決定讓自己幾乎全裸地暴露於低溫環境裡。他每天起床就是到曼徹斯特的橄欖球場，進行例行嚴格訓練：傳球、踢球、被球員擒抱攔截，此外他也做重量訓練。例行訓練結束後，馬肯紀通常會回到更衣室沖熱水舒緩身體痠痛，但這天球場附近的停車場卻出現一座巨型密閉室，他與幾位隊友走進裡面，馬上感受到一股冷冽的空氣迎向他們。馬肯紀早就想嘗試稱為全身冷療法（whole-body cryotherapy）的低溫治療，希望能藉此舒緩痠痛。在幾天內完成了數次兩分鐘療程後，馬肯紀還發現了其他好處，他回憶道：「我馬上感到神清氣爽，睡眠品質也變好了。」沒多久全身冷療法就成了馬肯紀每星期四次的例行治療：他只穿著人造纖維彈性短褲、手套、襪子、拖鞋以及頭帶保護身體不被凍傷，在低溫的空氣中放鬆筋骨。他的隊友也都採取同樣的防凍措施進行冷療法。

熱中冷療法的不只有馬肯紀與他的橄欖隊隊友，還包括美國職業籃球員科比．布萊恩（Kobe Bryant）與詹姆斯（LeBron James）等明星運動員；一些報導也指稱，好萊塢明星丹尼爾克雷格（Daniel Craig）與珍妮佛安妮斯頓（Jennifer Aniston）也都曾接受冷療法。美國冷療法市場正開始成長：各球隊引進冷療法以調理球員身體狀況，而健康中心則用冷療法讓顧客放鬆、減重以及對抗任何老化跡象。美國德州達拉斯的一家行銷全身冷療法儀器的大經銷商CryoUSA說，2011年至今，他們已在全美各地賣了200台儀器，預期接下來幾年總銷售額還會有更大的成長幅度。

但冷療法其實沒有科學根據。去年7月，美國食品及藥物管理局（FDA）提出警告，指出沒有科學證據支持冷療法可舒緩肌肉痠痛、失眠、焦慮或任何其他效益，反而有可能造成凍傷、燒燙傷、眼睛傷害或甚至窒息。FDA回應*Scientific American*的詢問時還表示：「FDA尚未核准全身冷療法，而且也沒有證據支持這些廠商宣稱的醫療效益。」FDA是根據文獻評估以及一般認為人體暴露於寒冷空氣中會產生的相關危害，才提出這樣的警告，不僅如此，冷療法費用昂貴，五次兩分鐘的療程就要價數百美元。

### 置身於冷冽空氣中

低溫治療的概念源自1970年代末期的日本，當時冷療法被吹捧成可舒緩多發性硬化症或風濕性關節炎患者的關節疼痛；1990年代在西歐越來越受歡迎，但一直到最近10年才在美國與澳洲崛起。隨著冷療法的風行，宣稱可以治療的疾病也突然大增，根據最新的市面廣告宣稱，冷療法不僅可治療痠痛，還能對付氣喘、阿茲海默症等各種疾病。

全身冷療法源自廣泛接受的物理標準冷療（利用冰袋與冰水浴治療急性軟組織傷害）理論，醫師在治療扭傷或挫傷的腳踝時，通常會建議冰敷做為療法之一。臨床研究發現，冰敷受傷部位5～15分鐘，就能把皮膚溫度降到13℃以下，藉此減緩神經系統傳遞疼痛訊息。冰敷或許還有其他療效，英國烏斯特大學運動醫學研究人員布里克萊（Chris Bleakley）說，動物研究發現，冰敷可以減少受傷部位的白血球，因此能對抗傷害造成的發炎反應，但冷療法是否真能產生同樣效益，仍是未知。現今冷療法是利用液態氮冷卻密閉室裡的空氣至-129℃以下，液態氮的溫度雖遠低於冰點，但冰冷空氣並非直接貼著皮膚而是圍繞皮膚外，因此不會讓皮膚的深層組織溫度下降；而冰敷是直接貼著身體部位，低溫容易穿透皮膚與脂肪到達受傷軟組織。

布里克萊與其他研究人員於2014年分析了冰敷、冷水浴以及全身冷療法的相關研究後發現，冰敷最能降低皮膚與肌肉的溫度，舉例來說，冰敷10分鐘可以讓皮膚溫度降低17.8～26.1℃，但3分鐘的全身冷療法（為保

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# 冷療法真有效？

現今冷療法是利用液態氮冷卻密閉室裡的空氣至-129℃以下，液態氮的溫度雖遠低於冰點，但冰冷空氣並非直接貼著皮膚而是圍繞皮膚外，因此不會讓皮膚的深層組織溫度下降；而冰敷是直接貼著身體部位，低溫容易穿透皮膚與脂肪到達受傷軟組織。

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# CWI vs. WBC

- 原理與機轉不同
- 生理變化情形不同
  - WBC不會造成深層肌肉溫度與血流下降
    - 衛星細胞活化？
    - 胺基酸運送？

Mawhinney et al. (2017). *Medicine and Science in Sports and Exercise.*

# 感謝聆聽

Thank you!