

Summary Review - Stretching

Q: Should we stretch before or after exercise to assist recovery?

Evidence available:

Outcome measures muscle soreness, injury risk and performance.

Interventions are static stretches and PNF stretching, most as part of warm ups/cool downs, no papers found on dynamic warm ups.

Most of the studies measured where for single event interventions pre and post activity, only one looked at regular stretching and its effect on performance.

Very little information on the effect of cool downs on recovery.

**A: Pre activity there is no significant evidence to indicate stretching will reduce muscle soreness injury risk or increase performance.
The evidence suggests that static stretching may impair some types of performance.**

A: Post-activity there is not enough evidence to make a judgement about the effects of stretching as part of a cool down but there is no evidence to suggest it impairs performance (See also multi interventions summary)

A: Regular daily stretching may enhance performance including speed and strength.

Further research needed: dynamic stretching as part of warm up, and in regular stretching and its effects.

Recommended refs - See blue highlighted refs in table and in multi interventions table on next page.

Pre or Post Stretching:

OUTCOMES: Performance, injury risk and muscle soreness

Title	Authors	Source	Keypoints	Conclusion	Comments
Acute changes in passive stretching and range of motion post-stretching	Whatman C. et al New Zealand	Physical Therapy in Sport 7 (2006) 195-200	<ul style="list-style-type: none"> • Pre event isolated exs hamstring • Performance related • Increases range but not necessarily for longer than 5 mins 	Little evidence to support pre event static stretch to reduce injury risk or improve performance.	V small study -9 No info on recovery
Stretching before and after exercise: effect on muscle soreness and injury risk	Andersen JC	Journal athletic training july/sept 2005 vol40 iss3 p218-220	<ul style="list-style-type: none"> • Review • Immed before or after exs • Any technique • Outcomes: muscle soreness and injury risk 	<ul style="list-style-type: none"> • Based on herberts review • No statistical difference either outcome 	Non elite
Effect of stretching on sport injury risk: a review	Hart L	Clinical journal of sport medicine 2005 15(2),113	<ul style="list-style-type: none"> • Systematic review • 6 articles reviewed from a possible 361. others didn't fit criteria of review 	<ul style="list-style-type: none"> • Evidence deemed limited but showed no significant effect on reduction injury 	
Effects of stretching before and after exercising on muscle soreness and risk of injury: systematic review	Herbert RD et al	BMJ 2002 325(7362),468	<ul style="list-style-type: none"> • Systematic review • 5 studies • Non elite athletes/untrained/army • Outcomes: soreness/injury risk/performance • Static stretching 	<ul style="list-style-type: none"> • Stretch before or after: no increased protection against muscle soreness • Stretch before: no decrease in injury risk. No measures for stretch after. • Insufficient research to determine effects on performance. 	
Does stretching improve performance? A systematic and critical review	Shrier 1	Clinical journal of sports medicine 2004 14(5) 267-273	<ul style="list-style-type: none"> • Review • 23 studies 	<ul style="list-style-type: none"> • Acute bout of stretching showed no increase force, jump ht but was contradictory for running speed • Regular stretching; increases force jump ht and speed, no effect on running economy 	

When and whom to stretch?	Shrier I	Physician and sportsmedicine March 2005 vol33 is3 p22 5p	<ul style="list-style-type: none"> • Overview of the research • Static stretch and PNF • Evidence based • Differentiates stretching before and after exs and regular daily stretching 	<ul style="list-style-type: none"> • Athletes with good economy of motion les effect than those who haven't. • Stretch before does not reduce injury risk • Regular stretching: increases force power and speed but not running economy • Reduced injury risk if stretch before and after and at other times as well. 	Not a true systematic review. Some author opinion. Numbers enough to be significant? Other factors such as training methods may influence results of some studies
The impact of stretching on sports injury risk: a systematic review	Thacker SB et al	Medicine and science in sport and exercise March 2004 36(3) 371-378	Same protocol as Hart	Same results as Hart	
Prevention of running injuries by warm up cool down and stretching exs	Van Mechelen et al	American journal of sports medicine 1993 21(5) 711-719	<ul style="list-style-type: none"> • Standardised warm up and cool down • 421 runners 2 groups • Outcomes: diary and injury rate 	Did not reduce injury rate	
The efficacy of stretching for prevention of exercise related injury: a systematic review of the literature	Weldon SM	Manual therapy 8(3) 141 -150	<ul style="list-style-type: none"> • Systematic review RCT and CCT. • Injury prevention only 	<ul style="list-style-type: none"> • Poor quality studies • Two highest scoring showed no significant effect on injury reduction 	
Does warming up prevent injury in sport?	Fradkin A	Journal of sports science and medicine 2006 9 214-220	<ul style="list-style-type: none"> • Systematic review • 5 studies over 40 years • 3 found did reduce risk, 2 didn't • 3 +ve studies had more focus on increasing body temp exs and reduction risk also related to participant type and type sport. • 2 -ve studies more focussed on stretching. 	<ul style="list-style-type: none"> • More evidence in favour than against in reducing risk of injury • Risk reduction may be greater if warm up relates to sport and participant same ages. 	Some evidence. Review info taken from sports injury bulletin. Not got paper yet.

<i>Stretching: mechanisms and benefits for sport performance/ injury prev</i>	<i>Weerapong P</i>	<i>2004 Physical therapy reviews 9(4) 189-206</i>	<i>Paper not available. Also has a paper in effects of massage in recovery.</i>		
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SUMMARY

Specific measurement issues:

Papers were found which measured performance post stretching but there was no mention of recovery issues: useful for another review but not this one.

Pre and post stretching specific recovery issues

Title	Authors	Source	Keypoints	Conclusions
Pre stretching	Many	pubmed	<ul style="list-style-type: none"> All outcomes based on immediate performance for pre stretching No papers on effect of recovery from exs. 	Not for review for recovery group. But effect of warm up on performance worth reviewing for another time.

Cryotherapy

Q: should we use Ice baths post activity?

Evidence available:

Outcome measures muscle soreness, function and performance.

Study interventions done post activity

Loughborough studies were on elite athletes, other studies untrained subjects.

Variations in length of time of intervention and temp

Not much attention to psychological input or discomfort levels of the intervention

Only one research group (Loughborough) has reported long term as well as short term effects of repeated v single ice baths.

Research exists on ice applications, and also pre activity ice jackets etc for performance: not considered as part of this review.

A: No.

The effects of repeated ice baths over a period of time suggest they would impair performance. Single use there is definite analgesic effect and some physiological and possible psychological benefit, but can this be obtained in another way without the same detriment: nutrition, compression analgesia, NSAID's? (See also multi interventions summary)

There is also not enough evidence to suggest that contrast bathing as part of recovery is any more effective.

A: Yes possibly.

Not many studies have looked at ice immersion post bruising and physical damage as part of recovery, although they have ice applications for acute injury and the evidence here is positive.

(Comment: ice baths have psychological effect on some players so if their use is to be reduced, I would recommend a weaning off /education /alternative intervention period first!)

Further evidence needed: one off ice baths under certain circumstances. Contrast baths.

Recommended refs - See blue highlighted refs in table and in multi interventions table.

Ice /contrast water therapy
Outcome measures:

Title	Authors	Source	Keypoints	Conclusions	Questions?
Influence of cryotherapy on indices of muscle damage following prolonged intermittent shuttle running exercise	Bailey DM Erith SJ et al	Journal of sport science 2006 (in press?)			
The effect of cold water immersion on indices of muscle damage following prolonged intermittent shuttle running exercise	Erith SJ, Bailey DM et al	Journal of sports science 2006 in review			
Do Ice baths Work?	Bailey DM	Lecture attendance ACPSM July 2007 and SIS high performance symposium.	<ul style="list-style-type: none"> Evidence based Study elite male rugby 90 mins, loughborough intermittent shuttle test 7 days testing post Control and intervention with placebo. 10 mins x10oc lower limb immersion Short term and long term effects 	<ul style="list-style-type: none"> Short term analgesic effect and possible increase recovery time. Long term: repeated effects can decrease performance Conclusion: everyone recovers; ice baths don't necessarily increase the rate of recovery and can impair performance if used repeatedly. 	presentation available Evidence based with good quality and tested method of measuring recovery. Have measured other interventions same model: contrast baths:
Temp changes in the human leg during and after 2 methods of cry therapy	Myrer JW, Measom G et al	J athletic trainer 1998 33 25-29	<ul style="list-style-type: none"> 20 min intervention 10o whirlpool or ice pack Subcut temp and muscle temp 	Whirlpool maintained prolonged significant temp reduction post treatment	Just informs cooling effect not effect of the cooling on recovery
Contrast baths do not cause fluctuations in human gastrocnemius intramuscular temp	Higgins D	J athletic trainer 1998 33 336-40	<ul style="list-style-type: none"> 31 min warm whirlpool v 31 min contrast Intra musc temp only measure 	Temp increase not deeper than 4 cms	
Key word: Ice bath	Multiple pages of anecdotal comments and products	Google	Anecdotal reports and equipment		

Ice water immersion and delayed onset muscle soreness	Sellwood KI Brukner P Nicol A et al	BJSM epub 2007 Jan	<ul style="list-style-type: none"> • 4 mins immersion • Untrained subjects • Function : hop doms 	No effect	Untrained? Pain and hop only functional measures No trained athletes or performance measures
Methods Advantages and limitations of body cooling for exs performance	Marino	BJSM 2002 36 89-94	<ul style="list-style-type: none"> • Cooling pre exs data only 	Not tested on recovery just performance	
Interval cryotherapy decreases fatigue during repeated weight lifting	Verducci FM	J athl trainer 2000 oct 35 422-426	<ul style="list-style-type: none"> • Upper limb • Work velocity and power • Ice packs or ice towels • Intervals 	Higher work rate and velocity and power	Relevant for sports such as wt lifting judo? Recovery between bouts of exs.
Effects of ice massage ice massage with exs and exs on prevention and treatment DOMS	Isabell WK et al	J athl training 1992 27 208 -217	<ul style="list-style-type: none"> • 22 subjects • Rom, strength, perceived soreness, serum creatinine 	No result.	
Effect of whirlpool therapy on signs and symptoms DOMS	Kuligowski LA Lephart s et al	J athl training 1998 Jul 3 222-228	<ul style="list-style-type: none"> • Warm and cold and contrast • Ecc elbow flex • Post exs and 3 other sessions • 24 mins 	Cold whirlpool and contrast were better than warm or no treatment	
Functional Performance following ice immersion to lower extremity	Cross KM et al	J athl trainer 1996 apr 113-116	<ul style="list-style-type: none"> • 20 subjects soccer • 3 functional tests: shuttle 6m hop test single leg vertical jump • 20mins immersion 	Decreased immediate shuttle run result	Implications for immediate recovery?
Changes in lower leg blood flow during warm cold and contrast therapy	Fiscus KA	Arch phys rehab 2005 july 86 1404	<ul style="list-style-type: none"> • Measures arterial bloodflow • Crossover trial 24. 	Warm and contrast increases blood flow	Clinically relevant?
Alternating hot and cold water immersion for athlete recovery – a review	Cochrane DJ.	Physical therapy in sport Vol 5 issue 1 feb 2004 26-32.	<ul style="list-style-type: none"> • review 	Discussion physiological basis. Not enough research yet.	

<p>The effect of hydrotherapy on the signs and symptoms of delayed onset muscle soreness (see also pool recovery)</p>	<p>Vaile J, Halson S, Gill N, Dawson B</p>	<p>European Journal Of Applied Physiology Vol 102(4) March 2008</p>	<ul style="list-style-type: none"> • 1 control, 3 interventions over 8 month period: passive recovery, cold water immersion, hot water immersion, contrast water therapy • Strength Trained males test was leg press. 	<ul style="list-style-type: none"> • Measures: squat jump, isometric squat, pain, thigh girth and bloods at 24,48, 72 h post exs. • Cold water immersion and contrast therapy improved the recovery isometric force and dynamic power and a reduction in localised oedema. Hot water immersion was effective in isometric force recovery but had no affect on other parameters.. 	<p>Randomised cross over design.</p>
<p>Physiological Response to Water Immersion: a method for sport recovery (see also pool recovery)</p>	<p>Wilcock I, et al</p>	<p>Physical Therapy in Sport Vol 5 Issue 1. Feb 2004, p26-32</p>	<ul style="list-style-type: none"> • Overview of possible physiological responses 	<ul style="list-style-type: none"> • Intracellular – intravascular fluid shifts • Reduction muscle oedema • Increased cardiac output without increasing energy expenditure • Increased blood flow and possible nutrient and waste transportation • Psychological effect with reduced cessation of fatigue • Temps: cool to neutral temps may have best response 	

Multiple recovery interventions including ice or stretching

Title	Authors	Source	Key points	Conclusions	Comments
Rules for recovery	Grantham N	Sports Injury Bulletin June 2006	<ul style="list-style-type: none"> • Article only • Overview types of fatigue • Overview strategies 	Just an overview reflecting individual papers	
Effectiveness of post match recovery strategies in rugby players	Gill ND Beaven CM New Zealand	Bjism march 2006 40 (3) 260-263	<p>4 interventions: contrast baths, compression garments, low intensity active exs, passive recovery</p> <ul style="list-style-type: none"> • 23 players random • Cold 1 min cold 2 mins hot • Skins 12 hours 	<p>Use electrosonophoretic transdermal samples tested up to 84 hours</p> <p>Active, contrast and skins better than passive but no info on optimal duration or combination available</p> <p>Small sample?</p>	Good physiological and measurements refs
The use of recovery methods post-exercise	Reilly T, Ekblom B	Journal sports sciences June 2005 23(6) 619-627	<ul style="list-style-type: none"> • Soccer • Explores Best combination of recovery interventions to sustain repeated comps/training over short periods. • Accumulative fatigue, decreased immune system • Warm downs, fluids, restore energy levels, 	<ul style="list-style-type: none"> • Warm down helps recovery and sleep and benefits immune system: jog stretch and leg drainage in prone with shaking. Control group took longer to return to pre match values. Optimum recovery 72 hrs but improvements before in intervention group. • Deep water running: day or day after activity: study restored strength and reduced soreness post plyometrics • Restoration energy: hydration and nutrition. • Effects of overload due to repeated comps: describes effects, detrimental effects of supplements short term. • DOMS: plyo training helps, repeated bout effect, worse with local bruising. Nsaids,. Ice baths, Contrast baths not effective. Deep water running is. • Lifestyle factors: nutrition, alcohol moderation, sleep, • Concludes balance between training and recovery needed between matches. Multiple matches: recovery strategy essential includes tactics and psych. Regen metabolic reserves etc 	Evidence based but not a systematic review, best practice. Good refs. Very useful overview.

Physical interventions to enhance recovery in sport	Mike Snelling	ACPSM conference 2006	Anecdotal/ scientific all aspects of recovery includes ice compression active passive massage nutrition.	Presentation available from LCT by request to members of the recovery group but should not be reproduced: please email if wish to see it.	
Treatment and prevention of delayed onset muscle soreness	Connolly DAJ et al	Journal of strength and conditioning research 2003 17(1) 197 -208	<ul style="list-style-type: none"> • Excellent review of current research 	<ul style="list-style-type: none"> • Mechanism and symptoms of DOMS • NSAID's • Warm up and stretching and massage • Cryotherapy and compression • Active rest v exs • Alternative therapies • Nutritional supplements • Antioxident therapy • Gender and oestrogen • 	

Other interventions:

Compression garments

Vibration therapy.

Omega wave and other forms of electrical stimulation

Nutrition: potentially the major player in recovery alongside sleep?

Intermittent Compression egg flowstones?

Other Papers:

Water based recovery. Vibration. Nutrition

Title	Authors	Source	Key points	Conclusions	Questions?
DOMS can anything be done?	Nick Grantham	Sports Injury Bulletin research review Feb 2007	<ul style="list-style-type: none"> • 10 distance runners with DOMS • 2 groups, 1 group rested other did water exs prog. • 	<ul style="list-style-type: none"> • water exs group recovered quicker physiologically and symptomatically 	Paper Japanese: Effect of aqua exs on recovery lower limb muscles after downhill running. Journal of sports sciences 2006 24 8 835-842 Takashi J
Influence of vibration on DOMS following eccentric exs.	Bakhtiary A Et al	BJSM 41 3 march 2007	<ul style="list-style-type: none"> • 50 untrained subjects, 2 groups • Measured creatinine-kinase and pain VAS • Vibration pre exs. 	<ul style="list-style-type: none"> • Reduction in DOMS 	<ul style="list-style-type: none"> • Untrained subjects • Eccentric downhill walking • Practical application? • More research: Marco Cardinale?