



Review

Application of traditional Chinese therapy in sports medicine

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ABSTRACT

Chinese herbs have been used as dietary supplements to improve exercise performance. However, evidence-based studies for the use of Chinese herbs in sports remain scarce. Traditional Chinese therapy (TCT), a form of traditional Chinese non-pharmacological intervention, has remained in use for thousands of years in sports medicine. TCT is beneficial for sports injuries and in enhancing skill development, and is becoming increasingly popular among athletes, fitness enthusiasts, and individuals who regularly exercise. The therapeutic effects of TCT have been demonstrated by clinical and experimental studies, but using these modalities still is associate with potentially adverse effects. Further well-designed studies are necessary to confirm the efficacy of TCT in sports medicine. This review aims to summarize the application of TCT, discuss the issues surrounding TCT clinical research, and provide suggestions for applying traditional Chinese methods in the field of sports medicine.

Introduction

Traditional Chinese Medicine (TCM) in sports medicine mainly includes Chinese herbs, acupuncture, moxibustion, and massage. Chinese herbs are used as dietary supplements in exercise-induced orthopedic injuries and fatigue. The curative effects include improved endurance, accelerated elimination of vascular stiffness caused by centrifugal exercises, as well as improving the ability of the skeletal muscles to store adenosine triphosphate (ATP).^{1–3} However, the amount of high-quality evidence for the use of TCM is lacking, which limits the conclusions that can be made regarding their effectiveness. Moreover, some Chinese herbal products have been found to be contaminated with undeclared plant or animal material, drugs, heavy metals, pesticides or compounds called sulfites, which could cause asthma or severe allergic reactions and could even lead to organ damage.⁴ Studies of Chinese herbs used for medical applications have mixed results. In addition, non-pharmacological traditional Chinese therapies (TCT) such as acupuncture, moxibustion, cupping, and Tui Na (traditional Chinese massage) interventions, have shown positive results in reducing fatigue and inflammation, promoting analgesia, and improving sporting performance.

Acupuncture is a technique where practitioners stimulate specific points on the body, usually by inserting thin needles through the skin. This technique is recommended by the American Pain Society, the

National Institutes of Health, and the World Health Organization because acupuncture is an efficient and inexpensive method for relieving pain, emesis, respiratory disease, and central nervous system disorders.^{5–7} Acupuncture could also be utilized to manage sports injuries and enhance exercise performance, although current research mainly focuses on clinical case reports.⁸ Some trials have suggested that real and sham acupuncture are equally effective, indicating a placebo effect; however, a number of studies have suggested that real acupuncture may help ease certain types of pain.⁹ Moreover, studies further suggest that acupuncture stimulates the release of molecules produced by the body affecting areas in the brain involved in disease processes.¹⁰ Therefore, further well-designed studies are necessary to confirm the efficacy of acupuncture in sports medicine.

Moxibustion is a common analgesic method in TCT which consists of a burning moxa-stick containing active ingredients, which produces a thermal stimulation and affects the functions via meridians and acupoints.^{11–14} In the field of sports medicine, moxibustion is mainly used in reducing fatigue, inflammation, and improving exercise performance. Moxibustion still needs high-quality trials to prove its safety, but keep in mind that moxibustion may cause potential adverse reactions such as allergies, burns, infections, coughing, nausea, and vomiting.

Cupping is an external treatment method using combustion and suction through a cup with negative pressure, exerting a pulling effect on the body surface. Cupping therapy can alleviate muscle pain, accelerate

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Abbreviations:

TCM	Traditional Chinese Medicine
TCT	Traditional Chinese Therapy
PC5	Jianshi acupoint
PC6	Neiguan acupoint
LI11	Quchi
LI14	Binao acupoint
LI15	Jiayu acupoint
SJ10	Tianjing
SJ13	Naohui acupoint
SJ14	Jianliao acupoint
KI11	Yongquan acupoint
KI26	Yuzhong acupoint
LU1	Zhongfu acupoint
LU2	Yunmen acupoint
LU3	Tianfu acupoint
LU4	Xiabai acupoint
LU5	Chize acupoint
LU6	Kongzui
LU7	Lieque acupoint
SJ12	Xiaoluo acupoint
LR3	Zhangmen acupoint
SP12	Chongmen acupoint
SP13	Fushe acupoint
LR10	Zuwuli acupoint
GB28	Weidao acupoint
GB29	Juliao acupoint
GB34	Yanglingquan
BL37	Yinmen acupoint
BL53	Baohuang acupoint
BL54	Zhibian acupoint
BL57	Cengshan acupoint
ST29	Guilai acupoint

ST30	Qichong acupoint
ST36	Zusanli acupoint
LI9	Shanglian acupoints
LI10	Shousanli acupoint
CV4	Guanyuan acupoint
CV8	Shenque acupoint
DU14	Dazhui acupoint
DU20	Baihui
HT2	Qingling
FAI	Femoroacetabular impingement
RPE	Rating of Perceived Exertion
CK	Creatine kinase
BUN	Blood urea nitrogen
SOD	Superoxide dismutase
Bla	Blood lactic acid
BUN	Blood urea nitrogen
5-HT	5-hydroxytryptamine
DA	Dopamine
NE	Norepinephrine
Hb	Hemoglobin
ROM	Range of motion
TNF- α	Tumor necrosis factor- α
IL-6	Interleukin-6
IL-4	Interleukin-4
IL-10	Interleukin-10
DOMS	Delayed-Onset Muscle Soreness
INF- γ	Interferon- γ
MCP-1	Monocyte chemoattractant protein-1
VO _{2max}	Maximum oxygen consumption
VAS	Visual Analog Pain Scale
LDH	Lactate dehydrogenase
ATP	adenosine triphosphate
WADA	World Anti-Doping Agency

muscle recovery of exercise fatigue, reduce inflammation, and potentially prevent diseases.¹⁵ Some adverse reactions related to cupping have also been reported, including burns, koebnerization, and the development of discoid psoriasis plaques.^{16–18}

Tui Na (traditional Chinese massage) is a form of TCT defined as "a mechanical manipulation by applying rhythmical pressure and stroking, in order to improve the corresponding clinical symptoms".¹⁹ Based on experience and observations, coaches, athletes, and sports medicine professionals believe that massages have comprehensive benefits, such as increased blood flow, reduced muscle tension, and neurological excitability.²⁰ A survey of young male athletes found that common sports injuries include acute muscle strains, stress fractures, and bone stress injuries.²¹ The benefits of massages are expected to help athletes improve performance and reduce the risk of sport-related injury.²² Local massage is also suggested when combined with meridian-activating massage to have the best therapeutic effect on pain sensation, muscle strength, and improved range of motion (ROM) among different massage methods in sports-related soft-tissue injury.²³ Among students of different sports who suffer from sports injuries, massage had a positive effect on calf muscle spasm, contusion, ankle collateral ligament injury, and muscle strains.²⁴

Compared to Chinese herbs, TCT has the advantage of not causing dependence, fewer side-effects, easier use, faster effect onset, and increased popularity among athletes including elite athletes. TCT-related studies involve case reports, meta-analyses, controlled clinical trials, and animal experiments. This review focuses on summarizing the application of TCT in sports medicine and discusses issues regarding safety and effectiveness in TCT research.

Acupuncture

Acupuncture relieves sports injury symptoms

Currently, sports injuries have become a common affliction due to the increasing number of sports enthusiasts,²⁵ especially in elite athletes.²⁶ The role of acupuncture in treating sports injuries is being accepted by the public, such as in the treatment of swelling, pain relief, and tissue repair.^{27–29} In addition to surgical interventions and drug therapy, common upper limb injuries (shoulder impingement syndrome, rotator cuff tendinitis, sub-acute elbow pain and swelling, chronic soft-tissue injury of the shoulder and elbow), as well as lower limb injuries (femoroacetabular impingement, FAI), proximal hamstring tendinopathy, ganglion cyst, and acute ankle sprain) are relieved by acupuncture.^{27–36} In volleyball athletes with shoulder injuries who have a high muscle tone, needles are inserted into the shoulder trigger points (also called the "ah shi" acupoints) and left inserted for 10 min. After therapy, muscle tone in all participants returned to "normal" on palpation.³⁰ After a 5-week dry needling treatment in amateur tennis players with myofascial dysfunction and rotator cuff tendinitis, signs of shoulder impingement decreased and the strength of rotator cuff muscles improved.³¹ In patients with sub-acute elbow pain and swelling, after a 15-min treatment with four needles in the palpated areas of tender points, the function of the affected elbow returned to "normal" and the symptoms of pain, and swelling disappeared.³² However, this study has no objective measurements and may not be suitable in other cases. Dry needling applied into the trigger points (medial/lateral hamstrings) relieves pain during sitting and running in patients with proximal hamstring tendinopathy.²⁷ High-frequency electroacupuncture can also

relieve pain associated with a ganglion cyst. During therapy, needles are inserted into trigger points at Zusanli (ST36), Taichong (LR3), and the opposite sides of the cyst and stimulated at 5 Hz for 15 min.³³

Acupuncture is also used concurrently with other treatments. Acupuncture was performed on patients with chronic shoulder soft-tissue injury along with shoulder movement, and moxibustion was performed for 15 min when acupuncture ended. After therapy, the effective rate of the acupuncture group was as high as 96.67% on the Visual Analog Pain Scale (VAS).²⁹ A male racquetball player with myofascial dysfunction and shoulder impingement syndrome received treatment once a week for 7 weeks with a therapeutic subscapularis stretching. Dry needling was performed at the trigger points in the subscapularis muscle. Signs of “subscapularis stretch” and shoulder impingement were negative after the treatment, and the patient returned to playing racquetball.³¹ Electroacupuncture can also improve symptoms of FAI with spinal manipulative therapy and rehabilitation exercises. During electroacupuncture therapy, needles are inserted into the left hip muscles and points Chongmen, SP12; Zuwuli, LR10; Juliao, GB29; Baohuang, BL53; Zhibian, BL54 at a frequency of 2 Hz. The patient had no pain when performing daily activities and exercises after 6 weeks.³⁴ Acupuncturing Wuhu points (which are in the thumb radialis and are referred to as Dong Qi points) for 30 min a day along with ankle movement can decrease pain and improve joint function.³⁵ Furthermore, acupuncture from the shoulder to the hand for three weeks is also used to treat exercise-induced (exertional) rhabdomyolysis together with intravenous hydration with sodium bicarbonate.³⁶

Acupuncture interventions are used to treat muscle-related symptoms resulting from exercises, such as delayed onset muscle soreness (DOMS), impaired muscle tissue oxygenation, and fibromyalgia. It has been shown that DOMS induced by eccentric elbow flexion is relieved by acupuncture; the VAS score of participants decreased significantly after the acupuncture intervention. However, the maximum isometric voluntary force and mechanical pain threshold scores were not significantly different. Although acupuncture may have no effect on the mechanical pain threshold and muscle function, pain perception by exercise-induced muscle soreness is reduced.³⁷ However, Fleckenstein et al. found that acupuncture had no effects on DOMS, which might be associated with the cutoff for pressure pain threshold.³⁸ An acupuncture intervention for trigger points Guanyanshu (BL26) and Chengjin (BL56) increased the levels of oxygenated and total hemoglobin (Hb). Results showed that acupuncture stimulation at different locations modulated different oxygenation patterns to muscle tissue.³⁹ In addition, the needling stimulation resulted in increased muscle blood flow.^{40,41} Vas et al. in a randomized controlled trial found acupuncture treatment relieves the number and threshold of tender points in fibromyalgia patients.⁴²

In general, both isolated and combined acupuncture treatment can play an important role in relieving sports injury symptoms, reducing pain, and restoring normal joint function.

Acupuncture enhances sport performance

As one of the common TCM therapies, acupuncture can enhance recovery,⁴³ delay muscle fatigue, increase muscle excitability, and improve endurance.⁴⁴ Acupuncture may accelerate the recovery of an individual's athletic injury, improve movement patterns, and relieve muscle fatigue. Electroacupuncture at trigger points Lieque (LU7) and Hegu (LI4) or Jianzhi (PC5) and Neiguan (PC6) significantly enhanced blood pressure regulation, peak power output, and rate pressure product. However, using trigger point combinations Baihui (DU20), Sanjian (LI13), Yangxi (LI15), ST36, PC6, Sanyinjiao (SP6) or ST36, DU20, Quchi (LI11), Yanglingquan (GB34), LR-3 acupuncture had no effect on the exercise performance.⁴⁵ Dry needling into the infraspinatus improves muscle strength and thickness in muscle dysfunction of shoulder injuries. After acupuncture, external rotation force production was increased at 90° of abduction.⁴⁶ In addition, acupuncture also changed functional movement patterns. Dry needling into the triceps surae resulted in both

short-term and immediate-term changes in one of the functional movement patterns for the overhead deep squat pattern. Conversely, no marked influence was shown for the range of motion (ROM) and functional assessment measures after acupuncture.⁴⁷ Blood lactic acid (Bla) is one of the classical indicators of fatigue. Lin et al. found that the levels of maximum oxygen consumption (VO_{2max}), heart rate (HR_{max}) and Bla in basketball athletes were reduced after acupuncture in ST36 and PC6 acupoints. The findings provided a reference basis for the development of effective acupuncture programs to improve fatigue recovery in elite basketball players.⁴³

The positive effects of acupuncture on fatigue recovery have also been confirmed in animal experiments. Acupuncture effectively improved recovery from recovery in mice by inserting into trigger points Guanyuan (CV4), ST36, and Shenshu (BL23). The effect is associated with the upregulation of lactate dehydrogenase (LDH) activity, and the reduction of serum creatinine kinase (CK).⁴⁸ After acupuncture treatment at trigger points LI15, Binao (LI14), Jianliao (SJ14), Yuzhong (KI26), Zhongfu (LU1), Yunmen (LU2), Chize (LU5), Xiabai (LU4), Tianfu (LU3), Naohui (SJ13), and Xiaoluo (SJ12), muscle excitability and endurance increased. Acupuncture was performed at the acupoint for 15 min, and the central nerve reflex induced by the sensory nerve stimulation after acupuncture led to a change in the potential caused by muscle contractions, which lead to increased muscle strength and EMG signals at the stimulated site. Moreover, the flexor muscles, including the anterior deltoid, pectoralis major, and extensor muscles, including the posterior deltoid and triceps brachii, were enhanced after acupuncture.⁴⁴

Acupuncture improves sports hernia

Acupuncture also acts on exercise-related medical conditions, such as sports hernia. In cases of suspected sports hernias in soccer players, symptoms are relieved by combination treatments involving electroacupuncture, manual therapy, microcurrent, laser, rehabilitative exercise, and plyometric training. After receiving the co-intervention of acupuncture and other treatments, a reduced VAS score of 0/10 was seen in three patients, and all returned to play after the therapy session. The acupoints of the three patients were L2-L4, T10-T12, Guilai (ST29), Qichong (ST30), Shanglian (LI9), Shousanli (LI10); L2-L4, T10-T12, Fushe (SP13), ST29, ST30, Yongquan (KI11), Weidao (GB28); L2L4, T10-T12, ST30, LI10.⁴⁹

Moxibustion

Moxibustion decreases fatigue

Fatigue is a ubiquitous phenomenon in competitive sports, which can impair the execution of motor skills.⁵⁰ Fatigue manifests as decreased muscle strength; shortened exercise time; increased rating of perceived exertion (RPE), Bla, serum CK, and blood urea nitrogen (BUN) levels; and decreased activity of antioxidant enzymes such as superoxide dismutase (SOD).^{51–53} Previously, Zhong et al. concluded that moxibustion might relieve fatigue and was superior to passive rest.⁵⁴ In recent years, studies have further confirmed that moxibustion therapies relieve fatigue. Athletes were given 25 min moxibustion stimulation at ST36 and PC6 acupoints before daily exercise for 5 days. Results showed a decrease in RPE, BUN, and CK levels.⁵⁵ In another trial,⁵⁶ moxibustion at the ST36 acupoint for 30 min was performed on athletes 5 days before exercise or 30 min after exercise-induced fatigue. Fatigue was relieved by moxibustion and was more effective when completed 5 days before exercise. Blood levels of Bla, CK, and SOD were significantly reduced after the moxibustion treatment. Similarly, moxibustion intervention in badminton players after exercise effectively reduced CK and BUN levels.⁵⁷ In addition, Meng et al.⁵⁸ reported that DOMS is related to muscle fatigue and moxibustion intervention and had a significant analgesic effect.

Previous studies have shown moxibustion to increase hepatic

glycogen content,⁵⁹ enhance the ability to scavenge free radicals and lipid peroxides,⁶⁰ and increase SOD and other antioxidant enzyme activity,⁶¹ as well as promote fatigue recovery. Xu et al. recently⁶² reported that moxibustion on CV8 (Shenque) acupoint effectively relieves fatigue by regulating the content of neurotransmitters in the hippocampus of rats; 5-hydroxytryptamine (5-HT) level was significantly reduced, dopamine (DA) and norepinephrine (NE) levels increased significantly; the DA/5-HT ratio also increased.

Moxibustion reduces inflammation

Intense exercise increases the systemic inflammatory response,⁶³ which can lead to sports injuries.⁶⁴ Studies have shown that moxibustion has anti-inflammatory effects.^{65,66} Lu et al. performed moxibustion three consecutive times in the bilateral ST36 point in rats after exhausting swimming, and once every other day for 3 weeks.⁶⁵ The results showed that moxibustion significantly reduced the serum levels of pro-inflammatory cytokines (Interleukin(IL)-1 β and Interferon- γ) and the IFN- γ /IL-4 ratio and promoted the production of anti-inflammatory factors (IL-4 and IL-10); Similarly, Li et al. demonstrated that moxibustion can effectively reduce the expression of inflammatory factor IL-6.⁶⁶ After swimming-induced exhaustion, rats were subjected to three successive moxibustion interventions on both sides at ST36 (1 run for approximately 3 min) and moxibustion once every other day for 3 weeks. The results showed that the expression of IL-6 mRNA or protein had significantly increased in the hippocampus in rats after exhaustive swimming, which was reversed by moxibustion intervention. However, moxibustion did not significantly affect the levels of IL-1 β and tumor necrosis factor- α (TNF- α), which is likely because macrophages or monocytes cells were not significantly affected.⁶⁶

Moxibustion has potential adverse effects. A systematic review by Xu et al. reported that the adverse events caused by moxibustion include burns, infection, allergies, coughing, nausea, and vomiting, infection, and burns were most reported.⁶⁷ Park et al. performed a systematic review of adverse events after moxibustion use and found that the most common events were allergic reactions and burns.⁶⁸ Large superficial basal cell carcinomas were also seen as the result of repeated burning after moxibustion use.⁶⁹ A meta-analysis showed that blisters are also one of the adverse reactions easily caused by moxibustion.⁷⁰ Further, moxibustion treatment led to a spinal epidural abscess in a diabetic patient with focal cellulitis and osteomyelitis.⁷¹

Moxibustion improves exercise performance

Studies have proved that moxibustion therapy could enhance exercise performance through various biomarkers. Hua et al. found that moxibustion at ST36 and CV4 acupoint for 6 weeks enhanced the organism's hematopoietic functions, promoted regeneration and synthesis of Hb, reduce Bla accumulation, and increase exercise duration.⁷² Hb oxidized is associated with enhanced oxygen-carrying capacity, Bla is a common index of fatigue, and exercise duration is an index of endurance. Moxibustion performed at ST36 and CV4 acupoints promoted the formation of Hb and facilitated the clearance of Bla; thereby reducing fatigue. Meanwhile, exercise duration in rats being treated with moxibustion at the CV4 acupoint was significantly longer than the control rat not receiving moxibustion in a swimming-induced fatigue model.⁶¹ The extended time to exhaustion was likely related to the increase of superoxide dismutase (SOD). Gao et al. also found that the premature decline of skeletal muscle strength and endurance was delayed after 20 min of moxibustion at DU14 (Dazhui) and ST36 acupoints in rats, and that skeletal muscle endurance was improved.⁷³ Xiong et al. reported that a 1-week pretreatment with ST36 moxibustion for 15 min before exercise in rats effectively reduced the degree of structural damage and promoted skeletal muscle injury repair.⁷⁴ Nevertheless, the number of moxibustion treatments had different effects on the motor ability of rats. Xu et al.⁶² established a swimming-induced exhaustion model where exhausted rats

were subjected to different times of moxibustion intervention and exercise time were recorded. No significant difference in exercise time between the rats that received the moxibustion intervention 1 and 4 times compared to the false moxibustion group were found, whereas the exercise time of rats that received the moxibustion intervention 7 and 10 times was significantly prolonged.⁶²

Cupping

Cupping impacts exercise performance

Cupping is an important component of TCT and is helpful in multiple health conditions.⁷⁵ Previous systematic reviews reported that cupping therapy helps reduce pain and increase ROM.^{76,77} Chiu et al. found that a cupping intervention effectively improved soft tissue compliance, shoulder, and upper limb functions in baseball players.⁷⁸ A recent study also found that cupping therapy could reduce inflammation after strenuous exercises. Ekrami et al. randomly divided 21 male karate athletes into cupping, strenuous exercise, and combined treatment groups.⁷⁹ By assessing the changes in inflammatory markers before and after strenuous exercise, TNF- α and IL-6 levels in athletes receiving cupping therapy were significantly lower. Some studies suggest cupping therapy in athletes accelerates muscle fatigue recovery following an intense exercise period, and thus helped maintain sports performance. However, a single application of cupping therapy had no significant effect on the hamstring flexibility of football players. Different cupping positions or subcutaneous fat thicknesses were not collected or controlled in this study.⁸⁰ Meanwhile, cupping therapy has been associated with serious adverse events, such as acquired post-treatment hemophilia A.⁸¹ Case reports of hemorrhagic stroke caused by neck cupping⁸² and panniculitis induced by cupping therapy have also been reported,⁸³ which has brought the adverse reactions of cupping therapy to attention. Other adverse reactions related to cupping have been reported and include burns, koebnerization, and the development of discoid psoriasis plaques^{17–19} of which burns were found as the most common.⁸⁴

Tui Na (Traditional Chinese massage)

Tui Na decreases muscle stiffness

Regarding injury prevention, muscle stiffness reductions are ideal, as this allows for greater extension and potentially reduces stress on the musculotendinous structures.⁸⁵ Studies have shown that post-exercise recovery from measured muscle stiffness was more pronounced after the massage as compared to control subjects.⁸⁶ Muscle stiffness when ultrasound shear wave elastography was used to measure muscle stiffness returned to baseline values quickly after 7-min of massage in healthy volunteers. Nevertheless, given the very short time span of the beneficial effect, the functional consequence of the decrease in stiffness following massage is likely to be limited.⁸⁷ Similarly, massage after eccentric exercise has a greater effect on reducing muscle stiffness within a day rather than affecting recovery over several days in rabbits that were surgically instrumented with peroneal nerve cuffs for stimulation of the tibialis anterior muscle.⁸⁸ However, experiments have also confirmed that post-exercise massage had no treatment effect in alleviating altered muscle stiffness in major leg muscles for male recreational runners.⁸⁹

Tui Na increases joint range of motion

Evidence suggests that joint ROM is diminished for up to 5 days after eccentric exercise.⁹⁰ Furthermore, considering the link between lower limb ROM and walking/running economy and jumping performance, increasing ROM is beneficial in the execution of motor skills for competition and training.⁹¹ Massage has been shown to increase ROM in clinical studies. Dorsiflexion ROM increased in healthy recreational male athletes after a 5-min calf muscle handheld percussive massage

Table 1
Application of non-pharmaceutical traditional Chinese therapy in sports medicine.

Methods	Experimental objects	Location	Therapy sessions	Effects	References	
Acupuncture	Human	Subscapularis muscle	Once a week, 5 weeks	Shoulder impingement sign (-)	31	
		Subscapularis muscle	Once a week, 7 weeks	5/5 muscle strength Subscapularis stretch sign (-) Shoulder impingement sign (-)	31	
		Ah shi GB34	/	5/5 muscle strength Swelling↓ Pain↓ Tissue repair↑ Metabolites absorption↑ Blood-stasis absorption↑	29	
		Shoulder Ah shi tender points	10 min 15 min	Short-term pain↓ Pain↓	30 32	
		DU20, SJ10, HT2, LI11, LU5, LU6	30–60 min once a day, 15 times/course, 4 courses	Swelling↓ Inflammation↓ Edema↓ Joint function↑	28	
		Triceps surae Shoulder myofascial	/ /	Deep squat performance↑ Muscle thickness↓	47 46	
		From shoulder to hand LU7, LI4, PC5, PC6	/ /	Muscle strength↑ Rhabdomyolysis↓	36 45	
		PC6, ST36 LI14, LI15, SJ14, SJ13, KI26, LU1, LU2, LU4, LU5, LU3, SJ12	/ 15 min	Recovery ability↑ Muscle excitability↑ Muscle fatigue↓ Muscle endurance↑	43 44	
		Hamstring ST36, LR3	Once a week, 8–9 weeks 15 min once a week, 4 weeks 5 Hz	Joint motion↑ Pain↓ Ganglion cyst↓	27 33	
		SP12, LR10, GB29, BL53, BL54	Total of 6 weeks 2 Hz	Muscle coordination↑ Muscle strength↑ Muscle endurance↑ Lumbopelvic stability↑	34	
		L2-L4, T10-T12, ST29, ST30, LI9, LI10	Twice a week, 6–8 weeks 2 Hz	VAS score 0/10, return to play immediately	49	
		L2-L4, T10-T12, SP13, ST29, ST30, KI 11, GB28	Twice a week, 6–8 weeks 2 Hz	VAS score 0/10, return to play immediately	49	
		L2L4, T10-T12, ST30, LI10	Twice a week, 6–8 weeks 2 Hz	VAS score 0/10, return to play immediately	49	
		Wuhu points	30 min/per, once a day	Pain↓ Joint function↑	35 55	
	Moxibustion	Human	ST36	25 min, once a day, 5 days	Fatigue↓	56
				30 min once a day, 5 days	Fatigue↓	57
				10–20 min once a day, 12 days	Fatigue↓	65
			Rat		3 min three times a day, 11 days	Inflammation↓
		Rat		3 min three times a day, 11 days	Inflammation↓	66
		Mice		6 weeks	Exercise ability↑	72
		Rat		20 min once a day, 1 day	Skeletal muscle injury↓	74
		Human	PC6	25 min once a day, 5 days	Fatigue↓	55
		Rat	CV4	10 min, once a day, 20 days	Exercise ability↑	61
		Mice		6 weeks	Exercise ability↑	72
		Human	CV8	10–20 min once a day, 12 days	Fatigue↓ Exercise ability↑	57 62
		Rat		15 min, once a day, 7–10 days	Fatigue↓ Exercise ability↑	62 73
	Rat	DU14	20 min once a day, 1 day	Muscular endurance↑	73	
	Human	Biceps	20 min once a day, 2 days	DOMS↓	58	
Cupping	Human	Trapezius muscle	20 min, twice a week, 4 weeks	Soft tissue compliance↑ Limb functions↑	78 79	
		Posterior neck, bilateral neck, thoracic spine	20 min, once a day, 1 day	Inflammation↓	79	
Massage	Human	Hamstring	7 min, once a day, 1 day	No significant effect	80	
		Lower leg	10 min	Muscle stiffness↓ Power↑	86	
	Human	Lower leg	four phases (2 min of effleurage, 2 min of petrissage, 2 min of deep circular friction, and 1 min of effleurage)	Muscle stiffness↓	87	
	Rabbit	Hind limb	0.5 Hz, 10 N, 15 min	Muscle stiffness↓	88	
	Human	Calf muscles	5 min percussion treatment	ROM↑	92	
	Rabbit	Tibialis anterior muscles	0.5 Hz, 30 min	Leukocyte infiltration↓	94	
Human	Quadriceps	10 min	TNF- α , IL-6↓	95		

(continued on next page)

Table 1 (continued)

Methods	Experimental objects	Location	Therapy sessions	Effects	References
		Quadriceps	10 min	Pain↓	99
		Leg	15 min	Pain↓	100
		Thigh	30 min (15 min on each leg)	Pain↓	101
		Thigh	30 min	Pain↓	102
		Frontal thigh	10 min	Pain↓	103
		Arm	10 min	DOMS↓	109
	Rat	BL37, BL57, GB34	5 N, 9 min, 21 d	Exercise ability↑	113
	Human	Leg, hamstrings	9 min	Exercise performance↓	114
		Lower limbs	10–15 min	Sprint performance↓	115
		Lower limbs, craniofacial muscle groups	20 min	Exercise performance↓	116

treatment.⁹² Handheld percussive massage treatment is a novel approach for therapists and athletes and has gained popularity over the past few years. In a similar manner, after treating ligament and meniscus injury with massage and acupuncture, Lai et al. found that clinical symptoms significantly decreased, knee joint function improved, and knee ROM increased.⁹³

Tui Na two-sided influences infectious diseases

The inflammatory response associated with sports injury^{63,64} is reduced by massage.^{94–96} Application of a 30-min massage to an eccentrically damaged rabbit tibialis anterior muscle once each day over 4 consecutive days attenuated the amount of leukocyte infiltration and subsequent inflammation and edema, thereby facilitating the recovery of function compared to a non-massaged, eccentrically exercised muscle.⁹⁴ Crane et al. found that massage led to a decrease in the production of inflammatory cytokines, TNF- α and IL-6 caused by muscle fiber injury. In this study, quadriceps biopsies of 11 young male participants were separated after exercise-induced muscle damage.⁹⁵ Furthermore, a recent pilot work has shown that as the delay in massage application increases, effectiveness decreases for reducing secondary hypoxic injury.⁹⁶

Tui Na is safe but not entirely risk-free. To maintain the desired competitive state, the timing of the massage is worthy of further attention due to massage-induced transient muscle soreness.⁹⁷ Massage-related adverse events were monitored in several routine procedures, though serious adverse events are infrequent. For instance, nearly 80 essential oils have been shown to cause contact allergy.⁹⁸

Tui Na alleviates pain

Post-exercise massage has been shown to reduce the severity of muscle soreness. Bender et al. found that 10 min of massage to the quadriceps following recovery from habitual sporting activity (10-km run) was effective in reducing the numerical rating pain scale compared to a sham technique, but the magnitude of the effect was small.⁹⁹ Additionally, Wiewelhove et al. found that after 24 h of prolonged running, massage was still beneficial in reducing muscle soreness.¹⁰⁰ Massage intervention after exercise was shown to reduce pain in basketball players immediately after treatment and 24 h after.¹⁰¹ Male bodybuilders were asked to perform five repetition sets at 75%–77% of knee extension 1 repetition maximum. CK of extensor and flexor muscle groups began to decline 24 h after receiving a 30-min massage. Furthermore, soreness levels in the massage group after exercise were lower than that of the control group.¹⁰² However, found in the literature is a report that 3 days of sports massage could not improve the recovery after 300 maximal eccentric contractions of the quadriceps muscle bilaterally.¹⁰³

Tui Na prevents DOMS

DOMS commonly occurs between 24 and 72 h after unaccustomed eccentric exercise.¹⁰⁴ The sequence of DOMS events consists of the mechanical stress of exercise on muscle fibers, causing sarcomeres to rupture,¹⁰⁵ which is accompanied by swelling.¹⁰⁶ A systematic review and meta-analysis demonstrated that massage intervention effectively alleviated DOMS, as well as improve muscle performance after strenuous exercise.¹⁰⁷ Such studies provide the basis for a meta-analysis and more definitive conclusions on the massage therapy efficacy in facilitating recovery.¹⁰⁸ Massage was effective in alleviating DOMS by approximately 30% and in reducing swelling (upper arm circumference) after maximal eccentric elbow flexion. VAS and plasma CK activity also decreased.¹⁰⁹ Moreover, Davis et al. reported that massage was associated with a significant 13% improvement in DOMS. Indeed, the effect of massage on DOMS was small but statistically significant.¹¹⁰

Tui Na improves exercise performance

Massages were effective in decreasing Bla concentration and improving subsequent swimming performance in elite professional male swimmers after performing 200-m of front crawl swimming.¹¹¹ Massage was also shown to improve total power during the second but not the first ergometer cycling bout as compared to control subjects.⁸⁶ This experiment confirmed that a 3-min fingertip point massage increased aerobic performance of young healthy males by more than 10% by assessing VO_{2max} in groups by the 6-min Harvard step test twice: at baseline and after acupuncture session.¹¹² Animal experiment confirmed that massage significantly improved the sciatic functional index and inclined plate test by promoting the proliferation of Schwann cells in rats with sciatic nerve injury.¹¹³

However, research on the effects of pre-exercise massage on performance and injury prevention is limited. Fletcher found that pre-competition massage had no influence on the kinematic parameters of 20-m sprint performance. In addition, the pre-competition massage was inferior in comparison to active warm-up in preparation for 20-m maximal sprint performance. Additionally, combining massage with active warm-up had no effect on the 20-m sprint performance.¹¹⁴ The use of a pre-competition massage as a warm-up modality, whether alone or combined with a dynamic warm-up, was not beneficial in enhancing acceleration and sprint performance in collegiate track and field athletes. Utilization of a pre-competition massage remains controversial and may be considered time-consuming to the clinician and the athlete.¹¹⁵ Moreover, a pre-event massage was found to negatively affect muscle performance, possibly due to the increased parasympathetic nervous system activity and decreased afferent input with resultant decreased motor-unit activation. (see Table 1)¹¹⁶

Conclusions

Acupuncture plays an essential role in relieving sports injury symptoms, enhancing sports performance, and improving sports hernia. However, acupuncture can also induce adverse events such as pneumothorax,¹¹⁷ dizziness or syncope,^{118–120} nausea and vomiting,^{118–120} as well as lead to infections associated with acupuncture.^{120,121} The factors influencing the effects of acupuncture consist of the individual condition, types of acupuncture, session number, and duration, as well as the selection of acupoints and quantity of stimulus. Most acupuncture research in sports medicine focuses on the clinical effects with few studies elucidating the mechanisms. Previous studies have shown that acupuncture regulates the levels of hormones or neurotransmitters such as beta-endorphins, serotonin, dopamine, purinergic signaling, endocannabinoids, and cortisol.^{122–125} Torres-Rosas et al. in a recent study suggested that electroacupuncture at ST36 acupoint decreased the LPS-induced serum levels of TNF, IL6, interferon- γ , and monocyte chemoattractant protein-1 (MCP-1). In sepsis, the sciatic nerve's ability to control systemic inflammation is demonstrated by the electroacupuncture effect.¹²⁶ Future studies should explore valid and reliable evaluation methods, including a larger number of participants, standardized acupuncture techniques; search for underlying mechanisms, and potential targets for acupuncture treatment. Therefore, further well-designed studies are necessary to assess the efficacy of acupuncture in sports medicine to establish stronger evidence.

Moxibustion is definitely efficacious in the field of sports medicine. Different moxibustion acupoints, such as ST36, PC6, CV4, and CV8, have been applied to relieve fatigue, inflammation, and improve exercise ability. The duration of a single session ranges from 3 to 30 min. Moxibustion can stimulate the endogenous production of Dopamine (DA) and Norepinephrine (NE),⁶² avoiding the problem of the illegal use of stimulants to increase the release of DA and NE¹²⁷ to improve exercise performance. However, Meng et al. found that moxibustion had no significant change in the muscle strength and circumference, possibly due to the insufficient sample size and only one tender point was stimulated without combining with other acupoints.⁵⁸ Therefore, subsequent studies should further expand the sample size, stimulate multiple acupoints, and supplement clinical data. Currently, moxibustion therapy is infrequently used in sports medicine. Some participants have developed respiratory symptoms after exposure to the moxa smoke¹²⁸ and some developed burns^{129,130}; however, with the temperature-controlled at 60 °C and spacing controlled at 4 cm, moxibustion is safe.¹³¹ Given that moxibustion has always been associated with unclear effects and intervention time, the relationship between moxibustion intervention time and motor ability should be further explored.

Cupping is a promising rehabilitation method suitable for multiple location parts, such as the trapezius muscle and cervical and thoracic spine. Study results indicate increased soft tissue compliance, improved limb function, and reduced pain and inflammation. Despite a few cases of burns being reported,^{132,133} cuppings are still used in sports medicine, especially in elite athletes. Currently, most reports focus on clinical application trials, and documented mechanisms are fragmented. Therefore, the biological mechanism of cupping action needs further clarified. Meanwhile, researchers should further employ standardized treatment parameters (e.g., placement, pumping intensity, treatment time) to continue investigating the optimal delivery of cupping therapy.

Tui Na is relatively effective and safe, according to clinical reports and experimental documents. Different Tui Na therapies (such as effleurage, petrissage, and friction) have been applied to relieve pain, muscle stiffness, and DOMS. Numerous reports in the literature have confirmed that massage is an important component in rehabilitation and improves subsequent exercise performance. However, pre-exercise massage therapy seems to have a detrimental effect on athletic ability. Future research is needed to continually examine the relationship between sports massage performed before and after in both sprint and endurance athletes. Given that sports injury is related to the intensity and duration of exercise

and likely additive over time, determining when to implement massage intervention after exercise is worth exploring.

Future research

Plant or plant extracts, as ergogenic aids, enhance long-term endurance performance, muscular hypertrophy, and strength. Among them, taking Ginseng for ≥ 8 weeks can prevent the deleterious effects of overtraining and enhance physical performance.¹³⁴ Results have shown that *Rhodiola crenulata* and *Cordyceps Sinensis* effectively reduce the oxidative stress induced by forced exercise in mice, completing prolonged exhaustive swimming improved exercise endurance, accelerated the rate of blood lactic acid clearance, decreased serum CK level, and enhanced antioxidant enzyme activity.¹³⁵ Adequate administration of ginseng also improves mental performance.¹³⁶ In untrained adults, taking 350 mg *Panax notoginseng* capsule per day for 30 consecutive days increased endurance time by more than 7 min, and reduce maximum blood pressure and VO_{2max} in the 24th minute of endurance exercise.¹³⁷ A dose of caffeine ranging from 2 to 9 mg/kg body mass has been shown as an effective ergogenic enhancing aid, when taken at least 1 h prior to exercise or competition.¹³⁸ Moreover, sufficient evidence exists that ephedra improved aerobic endurance performance by reducing fatigue, increasing alertness, improving reaction time, and increasing strength.¹³⁹ Furthermore, ephedra is more effective in improving endurance when used with caffeine.¹⁴⁰ In addition, supplementation of *Rhodiola* during endurance exercise training also effectively improved lower extremity muscle strength.¹⁴¹ Therefore, Chinese herbal medicine still has potential application in sports medicine, especially for improving sports performance.

Recently, a significant increase has occurred in terms of positive cases of higenamine (which can be extracted from the Chinese herb *lotus plumule*) misuse in sportspersons. Human consumption of *lotus plumule* for three consecutive days causes urinary higenamine concentrations of 10.0 ng/mL which is above the World Anti-Doping Agency (WADA) reporting cut-off.¹⁴² Study suggests that athletes should avoid consuming *lotus plumule* during competition periods. Consequently, identifying the ingredients of Chinese herbs and ensuring the safety and legitimacy of their application presents additional challenges.

Submission statement

This manuscript has not been published and is not under consideration for publication elsewhere.

Authors' contributions

Benxiang He is the corresponding author on the review. Liang Kang is the first author and was responsible for collecting the materials. Liang Kang and Minjia Wang wrote the first draft of the manuscript. Yushi Hu helped in organizing the information. Bingxin Sun, Peijie Liu, Aishi Peng, Yumei He, and Zenghao Huang edited the review table. All authors have contributed to the manuscript revision and have read and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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