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The Use of Acupuncture in Sports Medicine

Melanie Sfara

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The Use of Acupuncture in Sports Medicine
A literature Review

By

Melanie Sfara

A Plan B project submitted in partial fulfillment
of the requirements for the degree

Of

MASTER OF SCIENCE

In

HEALTH AND HUMAN MOVEMENT

Approved:

_________________________                                         _________________________
Dennis Dolny                                                                                   Trek Lyons
Major Professor                                                                                Committee Member

_________________________                                                                                      
Lori Olsen                                                                                              Committee Member

Utah State University
Logan, UT
2013
ABSTRACT

Background: Acupuncture is one of the most popular forms of alternative medicine. It has been used to treat both chronic and acute injuries and illnesses for many centuries. Recently, it is being evaluated for an influence on human performance.

Objective: The aim of this study was to investigate the effect of acupuncture on both musculoskeletal injuries and athletic performance.

Methods: Published literature was reviewed based on certain inclusion criteria. Thirty total articles were included in this study.

Results: Acupuncture seems to be effective in pain reduction. However, this may not be long term. Increases in exercise capacity and decreased heart rates were also seen with acupuncture treatment.

INTRODUCTION

Traditional Chinese Medicine (TCM) has been around for centuries, mainly in the orient to cure a wide range of illness and disease. These medical practices have just recently been explored and are gaining acceptance in the United States. Although conventional western medicine was been slow in accepting holistic methods, the use of alternative therapies has greatly increased since the 1970s (Pelham, Holt, & Stalker, 2001). Traditional Chinese Medicine is referred to as Contemporary and Alternative Medicine (CAM) in the western community and includes therapies such as acupuncture, herbal medicine, breathing exercises, manipulation, and stretching. Presently, CAM has become very popular and is earning the attention of medical practitioners as well as the public (Meleger & Borg-Stein, 2000). It is estimated that 3,000 American physicians have integrated acupuncture into their practice (Koh, 2012). A National Health Interview Survey conducted in 2007 estimated that 3.1 million U.S. adults and 150,000
children received acupuncture in the past year. Limited scientific evidence is present for most CAM techniques, but acupuncture has the largest body of research for the field (NCCAM).

Acupuncture is believed to help many different pathologies and sicknesses, but there has been a growing prevalence in its uses for sports medicine (Young, 2005). Acupuncture is used frequently to treat both acute and chronic athletic injuries (Meleger & Borg-Stein, 2000). Musculoskeletal conditions have proven to be one of the main reasons for which patients turn to acupuncture and alternative medical therapies. The validity of the benefits of acupuncture is beginning to be analyzed in numerous studies (Meleger & Borg-Stein, 2000). Not only are the effects on musculoskeletal injuries being studied, but the effect of acupuncture on physical performance is also being considered (Pelham, Holt, & Stalker, 2001). It is suggested that acupuncture may enhance physical and mental performance. Questions are arising as to whether or not muscular strength, flexibility, and fatigue are affected by this method of TCM (Pelham, Holt, & Stalker, 2001). When evaluating the uses of acupuncture in the realm of sports medicine, all aspects must be considered.

Sports are becoming more competitive every day, and athletes are always looking to enhance performance. Recently, CAM practitioners began looking past injury treatment and began focusing on performance enhancement through physical and mental improvements (Pelham, Holt, & Stalker, 2001). Many athletes will go to great lengths to get an “edge” on the competition. The literature has demonstrated that athletes are among the most frequent users of CAM. Acupuncture has been proven to be a more natural, safe, and legal method to use as opposed to banned substances such as steroids (Koh, Freeman, Zaslawska, 2012). Although acupuncture is currently a legal medical treatment used by athletes, it is starting to pose questions of misuse as doping (Usichenko, Gizhko, Wendt, 2009).
THE PROCESS

The goal of acupuncture treatment is to maintain and achieve overall health by stimulating specific points on the body. Many techniques may be used, but the most frequently studied includes the penetration of skin (1in or 2.5cm deep) by disposable thin, solid, steel needles. The needles are then manipulated by electrical stimulation (electroacupuncture) or the hands and can stay in place for a few seconds or between 20-40 minutes. The specialized needles are inserted through the skin at determined pressure points. These designated locations are part of a linked system of channels, called meridians. There are 14 meridians that connect at least 2,000 known acupuncture points. These channels act as energy pathways around the body. The pressure points and pathways are chosen for the specific individual based on his or her diagnosis (Callison, in press). Acupuncture is based on the idea that the needles create pressure at predetermined points that release the body’s natural energy, which is referred to as qi (pronounced chi) (NCCAM).

Acupuncturists believe that meridians conduct energy from the skin to the internal organs. Acupuncture seeks to address the body as a whole and include the internal organs, the musculoskeletal system, and psychological variables (Callison, in press). The relationship between injury type and organ affected is very important. Acupuncture meets the needs of athletes through thorough and personalized care. Acupuncture has many proposed methods and uses that may be useful in athletics. Injuries may be prevented through the promotion of neurological and cardiovascular balance and homeostasis. When injuries occur, acupuncture is said to regulate nerve conduction and circulation in the area of inflammation. Pain could be managed the stimulation of endogenous opioids or endorphins. Endurance and energy may be enhanced through lung, liver, and digestive function. Also, muscle fatigue could be decreased
through acupuncture’s promotion of recovery (Miller, *Acupuncture for Athletes*). Acupuncturists believe that the body has two opposing forces; the yin and the yang. Yin is representative of the passive principle: slow and cold. Whereas Yang represents the active principle: hot and excited. Traditional Chinese Medicine believes that health is achieved by maintaining the balance of these two forces (NCCAM).

*Figure 1- Acupuncture Points*


**ANECDOTAL EVIDENCE**

The major field in which acupuncture is utilized is pain management. Acupuncture is now recognized as an acceptable form of pain management by the National Institute of Health.
(“Acupuncture Treatment for Athletic Injuries”). It is a method of treatment for menstrual cramps, nerve pain, arthritic pain, pain from injury, muscular pain, back pain, sciatica, tension headaches, and migraines. It is also used to treat many other conditions such as allergies, hot flashes, irritable bowel syndrome, urinary tract infections, heart burn, respiratory problems, skin conditions and many more (“Acupuncture and Eastern Healing Therapies”). Athletes are not only affected by sports injuries, but they also experience medical and psychological conditions and illnesses which can be treated with acupuncture. Recently, sports medicine acupuncturists have emerged and focus on injury treatment and athletic performance. The main goal of this profession is overall health for athletes through a mind and body connection (Callison, in press).

Sports medicine acupuncturists combine range of motion tests, orthopedic evaluation tests, palpation, and manual muscle tests with TCM techniques to evaluate injuries.

Matt Callison is a licensed acupuncturist that works alongside athletic trainers and physical therapists at The University of California San Diego. Callison has treated athletes such as Allan Houston from the New York Knicks, Steve Young and Jerry Rice from the San Francisco 49ers, and Canadian Olympian speed skater Kevin Overland. Matt Callison states that he can treat “any and all injuries” by combining alternative methods and traditional sports medicine. Both oriental and western medicine focus on proprioception. Using acupuncture at specific points increases communication with the central nervous system to reset muscle spindles and restore balance (Sklar, 2009).

Lisa Ripi is a traveling NFL acupuncturist who treats 40 NFL players in 4 cities. She works predominantly with the Jets, Giants, Steelers, Bengals, and Dolphins. Ripi focuses less on traditional established points and more on sore areas. She uses needles to increase blood flow and promote relaxation of tightened muscles. One of Ripi’s clients include Jets’ fullback, Tony
Richardson. Richardson is a regular to acupuncture and states that following a session including 120 needles, his soreness vanishes. Richardson has been quoted saying, “Think of the impact she has every Sunday” (Bishop, 2010).

THE MIND-BODY RELATIONSHIP

Acupuncture seeks to balance the energies of the body internally. The harmony within the body may be disrupted through both internal and external factors. Some internal factors may include: stress, injury, and emotions (Pelham, Holt, & Stalker, 2001). Acupuncture stresses the importance of the relationship between the mind and body. Many factors determine the performance of an athlete, but most would agree that psychological dynamics play a great role in competitive sports. The competitive nature of sports creates many stressors such as demands placed by coaches and parents, decreased self-confidence, the fear of losing, and nervousness or anxiety (Wimmer, 2004). Emotions can create and alter physiologic responses which include an increase in heart rate, muscle coordination and timing, respiration rate, and muscle tension and fatigue (Wimmer, 2004). Optimal performance requires the release of the proper brain chemicals, a focused mind, and relaxed muscles. Acupuncture and other eastern therapies (such as massage) have been proven to help with relaxation and focus (Wimmer, 2004). This provides the athlete with a psychological mindset which will be beneficial to the emotional and physical demands of competitive sport.

SIDE EFFECTS

Very few serious side effects have been seen when acupuncture is administered correctly. Complications are mainly from improper sterilization and utilization. Serious adverse effects that may occur include punctured organs and infections (NCCAM).
White evaluated computer data bases, text books, case reports, and surveys to summarize the adverse effects that may be seen with acupuncture. There were a total of 715 adverse episodes included. Ninety of these were primary reports and 186 were secondary. Pneumothorax and central nervous system injury were the most commonly reported. Infection was also a common complication, which accounted for 204 primary reports and 91 secondary reports. Of all infection cases reported, over 60% were hepatitis B. External ear infection from auricular acupuncture was next common. There were 144 miscellaneous events reported which were comprised of seizures and drowsiness. White also uncovered 12 primary reports of death. Twelve prospective studies determined that the risk of acupuncture causing a serious adverse effect is estimated to be 0.05/10,000 treatments and 0.55/10,000 individual patients. Although serious adverse side effects may result from acupuncture, the likelihood is very low when administered properly (White, 2004).

PURPOSE

The purpose of the present study is to investigate the uses of acupuncture in the realm of sports medicine through recent scientific evidence. Current literature will be evaluated in order to determine whether acupuncture is effective in treating injuries and/or enhancing athletic performance.

INSPIRATION

The idea for this literature review came from my aspiration to integrate sports medicine with a more natural approach. It is my wish to bring light to the potential uses of alternative therapies. I personally desire to gain a better understanding and knowledge for the mechanism by which acupuncture is proposed to work.
METHODS

Search engines such as MEDLINE, GOOGLESCHOLAR, PUBMED, and EBSCOHOST were used to find published research articles. Keywords used in this search include the word acupuncture in combination with the words: sports, medicine, athletic, injury, lateral epicondylitis, doping, performance, recovery, strength, flexibility, DOMS, musculoskeletal, and osteoarthritis. Only studies that were published between the years of 1982-2012 were included in this review. The year 1982 was selected based off of articles used in two landmark studies published in 2000 and 2001. All research articles included in this review have been published in refereed journals and contained statistical comparisons. Additionally, each article must have at least one of the following inclusion criteria: the use of a control group, random assignment, or blinding of subjects.

A total of 30 articles were included in this review. Eighteen dealt with musculoskeletal conditions and 12 were related to athletic performance. Of the 30 articles, 12 involved the physically active population. Three hundred and sixty four total participants had an athletic or trained background.

MUSCULOSKELETAL CONDITIONS

Both acute and chronic musculoskeletal disorders are commonly treated by acupuncture, and many studies have examined the effectiveness of acupuncture of these conditions. When it comes to injuries, patients mainly seek alternative therapy to relieve pain and increase mobility (Meleger & Borg-Stein, 2000). Several research articles propose that acupuncture may increase local blood supply, cerebral blood flow, tissue oxygenation, metabolite exchanges, and ATP
production. It is also suggested that acupuncture may influence motor control and induce neurological reflexes (Franca et al, 2008).

*Lateral epicondylitis*

Patients with lateral epicondylitis often experience tenderness and pain along the lateral epicondyle during wrist extension. A randomized controlled study by Harker and Lundeberg assessed whether acupuncture was more effective than “mimic” acupuncture in treating lateral elbow pain. Mimic acupuncture, in this case, consisted of treatment along the same pressure points with a more superficial insertion point. Eighty-two out of 86 subjects completed the study. A physician that was blind to the experiment assessed the results. The outcomes revealed that 50% of the intervention group revealed good or excellent results compared to the 21% in the control group. Pain with gripping was also significantly decreased in the intervention group as opposed to the control group. However, none of the positive results were found to be present at the three month and one year follow-ups (Harker & Lundeberg, 1990).

In 2001, Davidson et al compared a treatment acupuncture group to an ultrasound group to examine the effectiveness of acupuncture in treating lateral epicondylitis. The treatment group consisted of 8 participants and the ultrasound group contained 9. Each group received 8 total treatments that were allotted 2-3 times per week. Pulsed ultrasound was performed for 10 minutes for the ultrasound group. A visual analog scale for pain was utilized before each treatment session and grip-strength scores were recorded. Pain was reduced and functional improvements were seen in both groups, and no significant differences were found between acupuncture and ultrasound treatments (Davidson, 2001).
Another trial compared true acupuncture to sham acupuncture in the treatment of lateral epicondylitis. This randomized, controlled, double-blind study consisted of 45 patients. The treatment (true acupuncture) group contained 23 participants and the control group (sham acupuncture) had 22. Treatment was given two times per week, for a total of ten treatments. In order to assess the results, pain level, duration, and frequency (on a scale of 0-5) were obtained at rest, in motion, and during exertion. Functional impairment was also evaluated using a DASH questionnaire. The acupuncture group had significantly lower pain levels after two weeks of treatment. However, both groups displayed a similar amount of pain during follow-ups. The treatment group also exhibited less functional impairment after two weeks and at the two month follow-up compared to the control group. This suggests that acupuncture might be effective in decreasing pain, but may not have long-lasting effects. This article also suggests that acupuncture could be successful in decreasing functional impairment in patients with lateral epicondylitis (Fink, 2002).

A randomized, placebo-controlled, double-blinded trial conducted by Molsberger and Hille evaluated 48 patients with lateral epicondylitis. The treatment group contained 24 participants receiving one treatment of true needle acupuncture. The placebo group consisted of 24 patients receiving one treatment of suggestive acupuncture. Suggestive acupuncture is when the skin is stimulated by a pencil-like probe, but there is no penetration. After one treatment session, each participant assessed their pain level using an 11-point box scale (0-10). Immediately after treatment, the true acupuncture group exhibited a 55.8% mean pain reduction, compared to the 15% mean pain reduction seen in the placebo group (Molsberger & Hille, 1994). This proposes that acupuncture may have an immediate analgesic effect in patients with lateral epicondylitis.
Table 1- Summary of Lateral Epicondylitis Studies

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Year</th>
<th>Procedures</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harker &amp; Lundeberg</td>
<td>1990</td>
<td>N=82, mimic vs. true, randomized, controlled, dbl blind</td>
<td>True acu group reported better results &amp; lower grip pain levels. No long-term results.</td>
</tr>
<tr>
<td>Davidson et al</td>
<td>2001</td>
<td>Acu(n=8) vs. ultrasound (n=9), 8 total treatments</td>
<td>No sig. dif. Between groups for VAS scores or grip strength</td>
</tr>
<tr>
<td>Fink</td>
<td>2002</td>
<td>N=45, true vs. sham, randomized, controlled, dbl blind, 10 treatments</td>
<td>True group ↓ pain levels at 2 wks, but not long term. ↓ Functional Impairment long-term.</td>
</tr>
<tr>
<td>Molsbergerger &amp; Hille</td>
<td>1994</td>
<td>N=48, true vs. fake, randomized, controlled, dbl blind, 1 treatment</td>
<td>True ↓ pain more than placebo</td>
</tr>
</tbody>
</table>

Shoulder pain

Shoulder pain has become a chronic and widespread disorder. In the United States, seven billion dollars are spent annually to treat conditions associated with the shoulder joint. Additionally, the incidence of shoulder pain has increased 100% over the last ten years. Common treatment for painful shoulder conditions include: physiotherapy, cortisone injections, and NSAIDs. When these methods are not effective, patients may turn to Traditional Chinese Medicine methods, including acupuncture (Molsberger et al, 2010).

An article in *Pain* examined the effectiveness of acupuncture in treating chronic shoulder pain (CSP). Participants were comprised of 424 patients with CSP (characterized by six or more months of pain and a VAS score of 50mm or greater). Random assignment placed each patient into traditional acupuncture, sham acupuncture, or conventional orthopedic treatment. The patients were blind to the type of acupuncture, and received 15 treatments over six weeks. Visual Analog Scale measurements were taken at baseline, after six weeks of treatment, and three weeks post-treatment. Directly following treatment, ITT analysis revealed that the traditional acupuncture group yielded a 68% improvement, sham acupuncture 24%, and conventional
orthopedic treatment 28%. At the three month follow-up, VAS scores revealed the following improvements: traditional acupuncture 65%, sham acupuncture 24%, and conventional orthopedic treatment 37%. There is a statistical significance (p<0.01) for traditional acupuncture over both sham and conventional treatments both post-treatment and at follow-up. Descriptive statistics also presented greater improvements in shoulder mobility (as indicated by the abduction and arm above head test) with true acupuncture treatments compared to the control group. Increased shoulder mobility in the acupuncture group was present immediately following treatment and at the three month follow-up. This article suggests that acupuncture is a beneficial and feasible alternative to conservative treatment (Molsberger et al, 2010).

A prospective, randomized, placebo controlled trial conducted by Guerra de Hoyos et al compared electro-acupuncture to non-penetrating acupuncture in treating patients with shoulder pain (due to soft tissue lesions). Patients were randomly assigned to one of two groups to receive two treatments per week for eight weeks. The primary outcome of this study was pain intensity (measured with VAS). Secondary outcomes included: pain intensity (Lattinen index), range of motion (goniometer), functional ability (SPADI), quality of life (COOP-WONCA charts), credibility (Borkoveck and Nau scales), and global satisfaction (ten-point analog scale). Measurements were taken at baseline, during treatment, and both three and six months post-treatment. Six months following treatment, the acupuncture group exhibited a significant decrease in pain intensity as compared to placebo acupuncture (VAS mean difference 2.0 (95% CI 1.2-2.9)). This trial also revealed that the acupuncture group demonstrated consistent, better results in every secondary category compared to non-penetrating acupuncture. Hoyos et al concluded that electro-acupuncture may be effective in treating shoulder pain long-term (Guerra de Hoyos et al, 2004).
Another randomized, controlled trial conducted by Ortega et al evaluated the effectiveness of acupuncture associated with physiotherapy in treating patients with painful shoulder. A total of 425 participants with the diagnosis of unilateral subacromial syndrome were recruited. All patients received three weeks of physiotherapy treatment. Additionally, each participant was randomly assigned to receive either acupuncture or mock TENS (transcutaneous electrical nerve stimulation) in addition to physiotherapy once a week. This study was primarily concerned with a change in the Constant-Murley Score (CMS) for functional assessment of the shoulder. This was measured one week post-treatment. The mean score on the CMS increased by 16.6 for the acupuncture group, compared to the 10.6 increase seen in the TENS group. The mean difference between both groups was found to be statistically significant (6.0 points; 95% CI 3.2-8.8 points, P<.0001). By the end of the trial, 53% of patients receiving acupuncture treatment had decreased analgesic consumption, compared to the 30% decrease among TENS patients. In conclusion, this trial revealed that acupuncture in combination with physiotherapy is capable of alleviating pain and improving function in patients with painful shoulder better than physiotherapy alone. Additionally, this study uncovered a reduction in analgesic consumption associated with acupuncture treatment (Ortega et al, 2008).

<table>
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<th>Author</th>
<th>Year</th>
<th>Procedures</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molsberger et al</td>
<td>2010</td>
<td>N=424, randomized, controlled, true vs. sham vs. conventional ortho tx, 15 treatments</td>
<td>True group has greater improvements and ↑ mobility acute and long-term</td>
</tr>
<tr>
<td>Guerra de Hoyos et al</td>
<td>2004</td>
<td>Randomized, controlled, electro acu vs. fake, 16 treatments</td>
<td>Electro acu. Long term ↓ in pain, ↑ in ROM and function</td>
</tr>
<tr>
<td>Ortega et al</td>
<td>2008</td>
<td>N=425, randomized, controlled, PT+acu vs. PT+TENS, 3 weeks</td>
<td>PT+acu ↑ function and ↓ analgesic consumption</td>
</tr>
</tbody>
</table>
**Knee osteoarthritis**

Acupuncture has been used to treat functional disabilities in TCM, including knee osteoarthritis. Lu et al completed a study that examined the effect of acupuncture on patients with knee osteoarthritis. Kinematics and kinetics of lower extremity gait before and after treatment were evaluated along with pain using a visual analog scale (VAS). Twenty participants with bilateral knee osteoarthritis were randomly assigned to either a control or experimental group. The experimental group consisted of 30 minutes of electro-acupuncture treatment, whereas the control group received sham treatment. The VAS and gait-analysis was performed before and after treatment. T-tests were used to compare group results as well as determine before and after changes. All measurable data before treatment was not significantly different among groups. The VAS score to measure pain significantly decreased in both groups, but was two times greater in the experiment group compared to control. The experimental group also showed an increase in gait speed and step length following post-acupuncture treatment. This study suggests that the improvements in gait were probably due to the decrease in pain, and proposes that both VAS scores as well as gait-analysis can be useful in evaluating neuromuscular and movement disorders (Lu et al, 2010).

A three-armed randomized, controlled trial compared acupuncture to sham acupuncture and conservative therapy in treating patients with knee osteoarthritis. The participants for this study included 1007 patients experiencing knee pain due to knee osteoarthritis for six months or longer. Conservative treatment consisted of ten visits to practitioners for a consultation and prescription of diclofenac or rofecoxib. For the true acupuncture group, ten sessions were administered over a period of six weeks. Sham acupuncture entailed needling at non-acupuncture points and also included ten sessions over six weeks. Success was defined as a 36% or more
improvement in Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) at 26 weeks. The true acupuncture group had a success rate of 53.1%, sham acupuncture yielded 51.0%, and conservative treatment produced 29.1%. Statistical significance was not reached for differences between true and sham acupuncture. However, both forms of acupuncture generated statistically higher success rates that conservative treatment alone. This article suggests that the improvements may be due to a placebo effect, differences in provider contact intensity, or the physiological effect of needling regardless of adherence to traditional principles (Scharf et al, 2006).

A similar trial conducted by Witt et al examined acupuncture compared to minimal acupuncture and a control group in patients with knee osteoarthritis. Participants were randomly assigned to one of three groups: acupuncture (n=150), minimal acupuncture (n=76), or no acupuncture (n=74). Both acupuncture and minimal acupuncture were administered in twelve sessions over 8 weeks. Minimal acupuncture was defined as superficial needling at non-acupuncture points. The main outcome was measured using the WOMAC index at the end of the eight week treatment period compared to baseline. After eight weeks, the treatment difference between acupuncture and minimal acupuncture was -8.8 (p=0.0002), and the difference between acupuncture and control was -22.7 (p<.0001). At a 52 week follow-up, there was no significant difference between groups. Initially following treatment, pain and joint dysfunction improved more in the acupuncture recipients when compared to minimal acupuncture and a control. As time passed, the benefit decreased and was no longer significant (Witt et al, 2005).

Table 3- Summary of Knee Osteoarthritis Studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Procedures</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lu et al</td>
<td>2010</td>
<td>N=20, randomized, controlled, electro vs. sham, 30 min treatment</td>
<td>Electro ↓ pain 2x greater than sham and ↑ Gait speed</td>
</tr>
</tbody>
</table>
Neck and back pain

Complementary and alternative medicine is frequently used to treat back pain. Kanodia assessed the perceived benefit of CAM for back pain using a national survey. The 2002 National Health Interview Survey was used to evaluate associations between back pain and various therapies. Reportedly, 6% of the US population used a CAM therapy technique to treat back pain. Of the respondents who stated using CAM techniques, 60% perceived a “great deal” of benefit. Multivariable logistic regression revealed that the most common reason that patients chose a CAM therapy was because “conventional medical treatment would not help.” The two interventions that yielded the highest perceived benefits include acupuncture (0.71; 95%CI, 0.37-1.38) and yoga/tai chi/qi gong (0.71; 95% CI, 0.41-1.22). Less effective methods consist of massage, relaxation techniques, and herbal therapy. This article demonstrates that the majority of respondents that used CAM techniques perceived some degree of back pain relief. Among these techniques, acupuncture was considered one of the most beneficial therapies in relieving back pain (Kanodia et al, 2010).

A prospective, comparative clinical trial conducted by Franca et al evaluated the use of acupuncture in treating tension neck syndrome (TNS). TNS is described as myofascial pain in the neck and shoulder regions (Franca, 2008). This study assessed the use of acupuncture in combination with physiotherapy (therapeutic exercise) opposed to the two methods used alone.
Forty-six patients with TNS were placed one of three groups: 1. Physiotherapy and acupuncture, 2. Acupuncture, 3. Physiotherapy. Each group completed one-two sessions weekly for ten weeks. Assessments included visual analog scales for pain intensity and muscle tension, the Neck Disability Index, and the cranio-cervical flexion test to evaluate isometric neck muscle strength. All measurements were taken before treatment, after the ten week treatment period, and after 6 months as a follow-up. All three conditions showed improvements both after ten weeks of treatment and at the six month follow-up (p<.001). The combination group was superior to the physiotherapy group in pain measurements and functional disability improvements (p<.05). The combination group also had higher isometric neck muscle strength compared to the acupuncture group (p<.05) and the physiotherapy group (p<.001). All improvements were still seen the six month follow-up (P<.05). The data in the study proposes that acupuncture may enhance rehabilitation of tension neck syndrome when combined with physiotherapy. It is suggested that acupuncture may help relieve pain and relax muscular tension by inhibiting the pain-spasm-pain cycle (Franca, 2008).

In 2006, Brinkhaus et al compared acupuncture to minimal acupuncture and a control in patients with low back pain. A total of 298 participants were randomly allotted to one of three groups: acupuncture, minimal acupuncture (superficial needling at non-acupuncture points), or no acupuncture (control). Acupuncture and minimal acupuncture were administered by certified acupuncture physicians. Twelve treatment sessions were completed with each patient over eight weeks. The participants filled out questionnaires at baseline and at 8, 26, and 52 weeks. Pain intensity was also measured using a visual analog scale (0-100mm) at baseline and after eight weeks of treatment. After eight weeks of treatment, pain intensity decreased by a mean of 28.7 ± 30.3 mm in the acupuncture group, 23.6 ± 31.0 mm in the minimal acupuncture group, and 6.9 ±
22.0 mm in the control group. Acupuncture yielded statistically significant differences compared to the control group at eight weeks, but no statistical significance was found between acupuncture and minimal acupuncture. This trial suggests that acupuncture may produce a placebo effect because no differences were seen between acupuncture and minimal acupuncture treatments (Brinkhaus et al, 2006).

Table 4- Summary of Neck and Back Pain Studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Procedures</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franca</td>
<td>2008</td>
<td>Randomized, PT vs. acu vs. PT+acu(combo), 10 weeks</td>
<td>Combo group showed less pain and disability and an increase in isometric neck strength compared to PT and acu alone</td>
</tr>
<tr>
<td>Brinkhaus et al</td>
<td>2006</td>
<td>N=298, randomized, controlled, acu vs. min acu vs. control, 12 treatments</td>
<td>Acu group different from control but not min acu. Placebo effect suggested.</td>
</tr>
</tbody>
</table>

Emergent Situations

A pilot study by Arnold et al assessed the efficacy of acupuncture in providing pain relief to acute, non-penetrating injuries in the emergency department (ED). A convenience sample of ED patients consented to using acupuncture as primary analgesia. Twenty of the 47 patients approached agreed to participate in this study. A visual analog scale (0-60mm) was used to assess pain levels before treatment, immediately after treatment, and every 30 minutes after. Within 72 hours of patient’s visit, a phone call was made to assess pain levels on a scale of one-to-ten. Time spent in the emergency department was also monitored. The median change in VAS score immediately following acupuncture treatment was 16mm of pain reduction (p<.0001). The median pain level at time of discharge and follow-up was a three; whereas patients that received conventional pain control medication rated an average value of 2.5. The average time spent in the emergency department was 135 minutes (actual range = 55-255 minutes), compared to the 90 minutes (actual range = 52-270 minutes) of a patient that did not receive acupuncture. The
present study did not determine a significant difference in time spent in the ED between groups. The authors concluded that acupuncture may be feasible in a fast-paced emergency department setting. The data also suggests that this treatment is efficacious in reducing pain both short term and long term in minor acute injuries (Arnold et al, 2009).

ATHLETIC PERFORMANCE

Acupuncture is most commonly known for its analgesic and healing affect. More recent studies are investigating the effects of physical performance such as strength, flexibility, and aerobic conditioning. Acupuncture is under review for performance-enhancing properties (Pelham, Holt, & Stalker, 2001).

Muscular Strength and Power

Literature suggests that acupuncture may be used as a tool for hypertrophy of muscles by stimulating testosterone and growth hormone production and causing specific muscle contractions. This claim seems to be unsupported. One study used a hand dynamometer and a leg extension isokinetic dynamometer to measure isokinetic and concentric muscular strength and endurance. Seventeen healthy patients were examined through a 15 minute single needle application of either a flexor muscle of the wrist, or the semitendinosus muscle. Neither muscle endurance nor strength tests changes, but electromyography readings were different post-acupuncture. This implies that neuromuscular activity is influenced by acupuncture. A controversial component of this study is that the needles were inserted directly into the muscle belly instead of a designated acupuncture point (Toma et al, 1998).

The immediate effect of acupuncture on strength performance was studied by Hubscher et al in a randomized, controlled crossover trial. Acupuncture was compared to both sham
acupuncture (needles inserted to non-acupuncture points) and placebo laser acupuncture (the laser device was deactivated). Thirty three recreational athletes were randomly assigned to one of the three treatment groups. Baseline measurements were taken before any treatments were received. One week was also mandatory between treatment trials to washout any carryover effect. Measured variables include maximum rebound height and quadriceps maximum isometric voluntary force (MIVF) through bipedal drop jumps. Surface electromyography (EMG) of the rectus femoris was recorded during a 30 second MIVF of knee extensors. Also, muscular endurance was characterized by mean power frequency (MPF). These tests were performed directly following treatment, and 15 minutes of rest was given between each test. Testing for statistical analysis included ANOVA and post-hoc paired-sample t-test. The following changes were seen in MIVF: acupuncture group = 46.6 Newtons, sham acupuncture = 28.8 Newtons, and placebo laser acupuncture = 19.6 Newtons. Statistical analysis revealed that there was no significant difference in MIVF changes between the acupuncture and sham acupuncture groups, but there was a significant variance between the acupuncture and placebo laser acupuncture group (p<.05). No significant treatment effects were seen for MPF or maximum rebound height. This study found that acupuncture was successful in increasing maximum isometric voluntary force of the quadriceps. The acupuncture group saw MIVF gains of 8% compared to the 5% after sham acupuncture and 3% following placebo laser acupuncture (Hubscher et al, 2010).

A trial conducted by Huang et al studied the effect of four weeks of unilateral electroacupuncture on bilateral dorsiflexion strength. Acupuncture points were chosen along the tibialis anterior. A control group was used for comparison, and each group contained 15 randomly allocated participants. Three sessions of electroacupuncture per week were administered over four weeks to the right leg only. Maximum dorsiflexion strength was
measured by having subjects lift weights in a range of motion of about 20 degrees about the ankle joint. Significant changes in strength were detected using repeated-measures analysis of variance with Bonferroni adjustment. In the electroacupuncture group, significant increases in strength were seen in both legs (right 21.3%, left 15.2%). This result was significantly higher (p<.05) than that of the control group (right 3.0%, left 4.8%). This study concluded that electroacupuncture at selected acupoints is capable of increasing dorsiflexion strength and may have implications in rehabilitation settings (Huang et al, 2007).

Another trial evaluated tibialis anterior muscle activity immediately following different acupuncture interventions. Local and adjacent acupuncture were compared in tibialis anterior force generation (or strength in Kilogram-force) evaluated by surface electromyography(EMG). This trial consisted of 30 volunteer participants (that met specific inclusion criteria) and was conducted single-blind. Patients were assigned to one of two groups: local acupuncture or adjacent acupuncture. Bipolar surface electrodes were attached to the tibialis anterior. A force transducer was placed on the subject’s foot and the floor. The EMG connected to a computer registered the KGF and root mean square before and after acupuncture at maximum isometric contraction. The root mean square and KGF values were analyzed using a student’s t-test. A significant decrease in root mean square values was seen in both local (t=-3.80, p=.00) and adjacent (t=6.24, p=.00) acupuncture groups following treatment session. There was no significant difference between these two groups. A decrease in force was observed in the local group following acupuncture (t=-2.98, p=.006). There was a significant decrease in strength in the local group compared to the adjacent group. (Costa & Araujo, 2008).

Muscular reactive strength was assessed in a study that contained 12 sportsmen. Acupuncture was compared to sham acupuncture and a control group in measuring 1-legged
drop vertical jumping performance. Acupuncture failed to produce a significant effect on either myoelectrical or kinematic measurements. The researcher did find a slight decrease in ground contact duration in the treatment group when compared to the sham acupuncture and control groups (Banzer et al, 2007)

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Procedures</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toma et al</td>
<td>1998</td>
<td>N=17, 1 acupuncture application for 15 min, wrist flexors and semitendinosus studied</td>
<td>No change in strength tests, EMG readings changed post-acupuncture treatment</td>
</tr>
<tr>
<td>Hubscher et al</td>
<td>2010</td>
<td>N=33, randomized, controlled, crossover, acu vs. sham vs. placebo, rectus femoris studied</td>
<td>No sig. dif. Between acu and sham for MIVF, but both sig. dif. from placebo. No sig. dif. In MPR or rebound height</td>
</tr>
<tr>
<td>Huang et al</td>
<td>2007</td>
<td>N=15, randomized, controlled, acu vs. control, 4 weeks, tib anterior studied</td>
<td>Sig. ↑ in dorsiflexion strength compared to control</td>
</tr>
<tr>
<td>Costa &amp; Araujo</td>
<td>2008</td>
<td>N=30, randomized, single-blind, local acu vs. adjacent acu, tib anterior studied</td>
<td>↓ force seen in local acu compared to adjacent acu</td>
</tr>
<tr>
<td>Banzer et al</td>
<td>2007</td>
<td>N=12, randomized, controlled, acu vs. sham vs. control, jumping performance studied</td>
<td>Slight ↓ in ground contact time in acu compared to sham and control</td>
</tr>
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</table>

Aerobic Conditioning Components

Along with muscular activity, acupuncture has also been hypothesized to effect aerobic conditioning. The proposed method of aerobic enhancement is through the increase of stroke volume and decrease of heart rate. The combination of these two factors can lead to greater aerobic efficiency and cardiac output. Acupuncture has also been viewed to reduce blood pressure through peripheral system vasodilation, which in turn increases blood flow (Pelham, Holt, & Stalker, 2001). Karvelas, Hoffman, and Zeni examined ventilation, heart rate, oxygen
uptake, and respiratory exchange ratio during maximal or sub maximal cycle ergometer exercise following a single application of acupuncture. This study was conducted on ten, healthy male participants. This trial found no significant differences in any of the physiological measures (Karvelas, Hoffman, & Zeni, 1996).

A recent study conducted in 2010 by Brenner determined that acupuncture benefits endurance training. This trial was performed by dividing runners training for a marathon into three groups: an acupuncture group, a placebo group, and a control group. Following the recording of their maximum pulse rates, each runner was instructed to run 5000 meters at 75% maximum pulse rate. This was to be completed once a week for four weeks. Heart rate measurements were taken at one, two, and five minutes post-run. Completion time was another measure to determine the influence of acupuncture on aerobic performance. The present study determined that all three groups showed improvement in completion times, but the acupuncture group had higher significant increases in performance (Brenner, 2010).

Another trial conducted by Ehrlic and Haber considered the effect of acupuncture on work capacity and aerobic threshold in 36 untrained male subjects during exercise. Acupuncture was administered once a week for five weeks. Patients in the acupuncture treatment group were able to perform at greater workloads and reached higher maximal exercise capacity than those in the placebo group. Along with these results, the treatment group also showed lower heart rates and both sub-maximal and maximal work levels (Ehrlic & Haber, 1993).

Another study also tested the effects of acupuncture of sedentary participants. Gential et al evaluated the long-term effect of acupuncture on physical performance in an ergospirometry test on the treadmill. Thirty-one untrained subjects were randomly assigned to either real
acupuncture, sham acupuncture, or a control group. Treatment was administered twice a week for five weeks. The real acupuncture group did not demonstrate a change in maximal oxygen uptake, but did record lower heart rate measures and demonstrated higher velocity at anaerobic thresholds compared to the sham and placebo groups (Gentil et al, 2005).

The acute effect of acupuncture on 20km cycling performance has been recently studied by Dhillon in a single-blind, repeated measures fashion. Twenty experienced male cyclists were observed for time to completion, RPE, VAS for lower leg pain, and blood lactate concentration. The only statistically significant finding was that the acupuncture treatment exhibited higher RPE scored compared to a sham and control group (Dhillon, 2006).

Table 6: Summary of Aerobic Conditioning Components Studies

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Procedures</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karvelas, Hoffman, &amp; Zeni 1996</td>
<td>N=10, single application of acupuncture, max or sub max cycle ergometer</td>
<td>No sig. findings for ventilation, oxygen uptake, RER, or HR</td>
</tr>
<tr>
<td>Brenner 2010</td>
<td>Marathoners, randomized, controlled, blind, acu vs. placebo vs. control, 4 weeks</td>
<td>Sig ↑ in performance in acu group compared to placebo and control</td>
</tr>
<tr>
<td>Ehrlic &amp; Haber 1993</td>
<td>N=36, randomized, controlled, blind, acu vs. placebo, 5 weeks</td>
<td>Sig. ↑ in max exercise capacity and ↓ in HR in acu group compared to placebo</td>
</tr>
<tr>
<td>Gentil et al 2005</td>
<td>N=31, randomized, controlled, blind, acu vs. sham vs. control, 5 weeks, ergospirometry on treadmill</td>
<td>No sig. effects of oxygen uptake. Acu group showed a ↓ in HR and an ↑ in velocity at anaerobic threshold compared to sham and control</td>
</tr>
<tr>
<td>Dhillon 2006</td>
<td>N=20, single-blind, repeated measures, acu vs. sham vs. control, 20 km cycling</td>
<td>Only sig. finding was an ↑ in RPE scores in acu group</td>
</tr>
</tbody>
</table>
Flexibility

Another component of physical performance which may be affected by acupuncture is flexibility. It is suggested that acupuncture is able to influence the nervous system and change EMG activity. This is the proposed mechanism by which acupuncture is able to relax and elongate the muscle (Pelham, Holt, & Stalker, 2001). Marcus and Gracer investigated 16 patients with rotator cuff tendonitis and capsular inflammation. The common symptoms among these patients included shoulder pain and a decrease in shoulder range of motion. Manual therapy techniques were used in conjunction with acupuncture to aid in the healing process. Following treatment, patients experienced less pain and an increase in shoulder motion (Marcus & Gracer, 1994).

A study published in Medical Acupuncture evaluated the effect of acupuncture treatment on hip abduction range of motion. This randomized, controlled trial utilized 44 participants assigned to one of four groups: 5-point acupuncture and stretching (G1), acupuncture in adductor magnus muscle (no acu-points) and stretching (G2), placebo acupuncture followed by stretching (G3), or acupuncture with no stretching (G4). Maximum range of motion for the hip abductors was measured with a flexometer pre and post-treatment. No significant differences were found between groups (p=.3999). However, and significant increase in hip abduction was seen in G1 (p=.007) and G2 (p=.0009). This suggests that acupuncture at acu-points and at no acu-points is capable of increasing hip abduction range of motion in combination with static stretching (Carvalho, Cabral, & Rubini, 2011).
Table 7- Summary of Flexibility Studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Procedures</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marcus &amp; Gracer</td>
<td>1994</td>
<td>N=16, manual therapy in combo with acu, patients with shoulder inflammation</td>
<td>↓ pain, ↑ shoulder ROM followed combined treatment</td>
</tr>
<tr>
<td>Carvalho, Cabral,</td>
<td>2011</td>
<td>N=44, randomized, controlled, acu at acu-points+stretch vs. acu at no acu-points+stretch vs. placebo+stretch vs. acu</td>
<td>Acu at acu-points+stretch and acu at no acu-points+stretch produced sig. ↑ in hip abductor ROM compared to other groups</td>
</tr>
</tbody>
</table>

### MUSCULAR FATIGUE

*Delayed Onset Muscle Soreness*

The effect of acupuncture on muscular fatigue has been examined through the study of delayed-onset muscle soreness (DOMS). Delayed-onset muscle soreness is muscular damage and fatigue which sets in a couple of days post-exercise (Usichenko, Gizhko, & Wendt, 2010). Hubscher et al investigated 22 participants placed into three groups: true acupuncture, mock acupuncture, and a control group. The non-dominant elbow flexors were the target of this study. Perceived pain, mechanical pain threshold, and maximum isometric voluntary force (MIVF) were all measured through the use of a visual analog scale (VAS), a pressure algometer, and a force transducer. Acupuncture was administered prior to the onset of DOMS, and it was applied both 24 and 48 hours following the onset. Measurements were taken before and after each treatment session. Final measurements occurred 72 hours after the induction of DOMS. The results concluded that pain perception was influenced by acupuncture, which was seen through the improvement in VAS scores. The acupuncture group showed significantly lower VAS scores compared to the sham acupuncture and control groups after 72 hours. However, neither muscle function nor mechanical pain threshold seemed to be effected (Hubscher et al, 2008).
Huguenin et al assessed the effect of trigger point acupuncture on posterior thigh pain in 59 male athletes. Participants were randomly assigned to receive one treatment of either true or placebo acupuncture. Follow-ups for improvements were made at 24 and 72 hours post-treatment session. The straight leg raise and hip internal rotation tests for both groups remained unchanged. Participants from both groups reported decreased pain and gluteal tightness. There were no significant differences between groups (Huguenin et al, 2005).

Another trial that evaluated the effect of acupuncture on DOMS used sham acupuncture in one leg and true acupuncture in the other to compare results in six athletes. DOMS was induced in both legs using heel raise exercises. The measured parameters include: ankle range of motion, max voluntary contraction, 1-legged vertical jump, and pain levels while stretching. At 48 hours after treatment, the participants reported less pain while stretching the true acupuncture leg as compared to fake acupuncture. This was the only significant finding (Terada, 2001).

Table 8. Summary of DOMS studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Procedures</th>
<th>Findings</th>
</tr>
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<tbody>
<tr>
<td>Hubscher et al</td>
<td>2008</td>
<td>N=22, randomized, controlled, blind, acu vs. mock, vs. control, elbow flexion with DOMS studied</td>
<td>Acu group showed sig ↓ in pain perception compared to mock or sham</td>
</tr>
<tr>
<td>Huguenin et al</td>
<td>2005</td>
<td>N=59, randomized, blind, true acu vs. placebo acu, 1 treatment, post. thigh studied</td>
<td>No sig. dif. Between groups for pain or gluteal tightness.</td>
</tr>
<tr>
<td>Terada</td>
<td>2001</td>
<td>N=6, controlled, blind, sham acu vs. true acu, plantarflexion studied</td>
<td>48 hrs post-treatment, pts. Reported ↓ in pain while stretching in true acu leg compared to sham acu leg</td>
</tr>
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</table>
**Carnitine**

Several researchers propose that acupuncture is an effective therapy for decreasing muscular fatigue, but the method behind this is unknown (Toda, 2012). Fatigue and weakness of skeletal muscle is associated with a drop in carnitine levels. It has been shown that acupuncture treatment is capable of increasing carnitine levels in skeletal muscle, thus acting as the mechanism for a decrease in fatigue. Toda studied the effect of acupuncture on lab mice. This experiment included a treatment group and a control group. The treatment group received a 15 minute session of acupuncture, and the control group did not receive any stimulation. The results showed significantly higher (p<.001) levels of carnitine in muscle tissue present in the acupuncture group (654.17±50.52) when compared to the control group (346.67±53.41). This article demonstrates that acupuncture may be able to increase carnitine levels, and therefore decrease skeletal muscle fatigue (Toda, 2012).

**Recovery**

A study conducted by Lin et al evaluated the use of acupuncture stimulation on recovery ability of male elite basketball players. Thirty university basketball athletes were randomly assigned to three groups: an acupuncture group, a sham group, and a control group. Acupuncture and sham acupuncture were administered fifteen minutes before exercise and continuing until exhaustion. The control group did not receive any treatment. Date measures were taken during rest period and at 5, 30, and 60 minutes post-exercise. Measures included heart rate, oxygen consumption, and blood lactate levels. A one-way ANOVA revealed that the acupuncture group had significantly lower heart rate and blood lactate levels than both the sham and control groups.
at 30 and 60 minutes post-exercise. The present article suggests that acupuncture may be capable of stimulating post-exercise recovery (Lin, 2009).

DOPING

Alternative medicine has been growing more popular among athletes and is starting to pose questions of misuse as doping (Usichenko, Gizhko, & Wendt, 2010). Literature suggests that the athletic population is among the highest users of alternative therapies. Athletes are known for their high goals and competitive spirit, which may lead to unconventional methods of injury prevention, healing, and performance enhancement (Koh, 2012). Acupuncture is targeted as a potential doping agent because of the analgesic effect and the release of endogenous opiates (Usichenko, Gizhko, & Wendt, 2010). Acupuncture is not currently classified as a doping mechanism. However, according the World Anti-Doping Agency (WADA), it may be an upcoming target for inclusion on the list. In order to be considered a doping agent, a method or substance must meet two certain criteria (Usichenko, Gizhko, & Wendt, 2010). First, it must alone, or in conjunction with another agent, enhance performance or have the potential to enhance performance. Secondly, there must be evidence that the method for substance creates a potential risk of harm to the athlete (Usichenko, Gizhko, & Wendt, 2010). Acupuncture has not yet been found to cause harm when administered properly and has therefore stayed off of the WADA list of doping mechanisms (Usichenko, Gizhko, & Wendt, 2010).

DISCUSSION

Acupuncture has been around for many centuries and works within connected channels in the body to treat many pathologies and sicknesses. Its recent prevalence in the field of sports medicine has been gaining acceptance and acknowledgement. Traditional Chinese medicine is
becoming a better established method of treatment. Acupuncture has been proven legal and safe, with few major side effects when administered correctly. Although not dangerous, the present study aimed to determine effectiveness in injury treatment and performance enhancement.

After reviewing numerous studies pertaining to sports injuries, many conclusions can be drawn. Acupuncture seems to have a prevalent use in pain perception. Many clinical trials have demonstrated that acupuncture may be effective in decreasing pain levels. Although there can be an initial decrease in pain, long-term benefits were not always present. Lower pain levels could lead to a decrease in analgesic consumption and may also have benefits in the emergent setting. Several trials also concluded that acupuncture is capable of increasing range of motion. The greatest increases in mobility were seen when acupuncture was combined with a physical therapy exercise program.

The effects of acupuncture on athletic performance seem to be less clear. Of the five reviewed articles pertaining to muscular strength, only one saw significant results in strength increases. Aerobic conditioning seems to be effected by acupuncture. Many studies found significant increases in exercise capacity and performance along with a decreased heart rate. The recovery study conducted by Lin et al even demonstrated decreased lactate levels and VO2max measures. Only two reviewed articles pertained to flexibility. Increases in flexibility were only seen when acupuncture was combined with stretching protocols.

Additional research, along with more strict protocols, are needed in order to efficiently assess the effects of acupuncture on human performance as well as injury healing. It appears that the main effect of acupuncture is pain perception. Protocols, treatments, and results may also depend on the acupuncture administrator. The current literature concludes that acupuncture may
have a number of positive effects on athletes, but may be dependent upon the individual, their beliefs, or the nature of the injury.
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moxibustion on physical performance by sedentary subjects submitted to ergospirometry


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