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The Effects of Massage and Cupping Therapy on Blood Lactate, Heart Rate and Mood State in Professional Football Players

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Abstract

Football is classified as anaerobic physical activity which undergo anaerobic glycolysis that tends to increase lactate production, resulting in muscle fatigue. The struggle to function of muscle leads to physical and mental issues in the football players. Massage and cupping therapy are soft tissue manipulation, which provide physiological and psychological benefits for the athletes. Thus, investigation of massage and cupping therapy as rehabilitative interventions in sports made it interesting in this study. Fifteen male professional football players volunteered for this study. The randomized crossover trial was adopted to investigate the effect of recovery interventions (cupping therapy, massage and rest) on blood lactate clearance, heart rate and mood state. After maximal anaerobic physical activity, the participants were randomly assign to receive each recovery intervention. The examinations of blood lactate and heart rate were carried out for each test session. Similarly, the Profile of Mood States questionnaire was used to measure mood state after receiving the interventions. There were significant main effects ($p<0.05$) for heart rate reduction in massage and cupping therapy groups at 10 and 20 min, while blood lactate clearance

exhibited the significant reduction ($p<0.05$) at 20 min post recovery time. No significant difference was found between each interventions in six dimensions of mood state; however, slightly higher score was found in vigor, a positive mood state in massage and cupping therapy groups compared to rest. These findings provide a clinical evidence about post-recovery utilizing massage and cupping therapy manipulate blood lactate clearance, heart rate and mood states in professional football players.

Keywords: Integrative medicine, massage, cupping therapy, mood state, football player

Introduction

In a football game, the players with greater strength, speed, power, and endurance may decide the most important moments within matches. The most prestigious international football tournament in the world, the FIFA World Cup, has an economic impact of billions of dollars on rewards and sporting events. It's undeniable that money in the game has attracted business leading to economic growth in many countries (Allmers & Maennig, 2009). Therefore, improved performance and rehabilitation among professional football players cannot be ruled out.

During the game, high-intensity actions including single and repeated sprints were performed by the players (Sporis, Ruzic, & Leko, 2008). These actions are classified as anaerobic exercise which is necessary to supply the energy molecule adenosine triphosphate (ATP) under the process of anaerobic glycolysis for muscle force production (Huertas, Casuso, Agustín, & Cogliati, 2019). The continuing of intensity exercise leads to over production of pyruvate which exceeds the oxidation rate of pyruvate dehydrogenase (PDH), resulting in lactate and hydrogen ions generation (Huertas et al., 2019). Moreover, hydrogen ions cannot be removed without sufficient oxygen so that it leads to an acidic environment interfering with the enzymes that control glycolysis struggle to function (Metzger & Moss, 1990). These consequences cause muscle fatigue due to the reduction of muscles functioning in response to contractile activity. Obviously, muscle fatigue interferes with sport performance due to a decline in the ability to generate force, velocity, and power output (Muangkram, Honda, Amano, Himeno, & Noma, 2020). Additionally, the decline of sport performance also causes psychological issues (Hemmings, 2001). Therefore, manipulation of fatigue after the game is necessary due to its physical and psychological issues for most of the athletes.

Numerous strategies have been used to improve athletic performance with the evaluations on physical and psychological ways. The most famous therapeutic and rehabilitative interventions in sports is soft tissue manipulation which can be applied by various techniques, such as using the specific equipment (cupping therapy) or using parts of the body (massage therapy) (Muangkram et al., 2020). These two techniques are familiar to Asians because they are common clinical practice in a traditional medicine.

Cupping therapy is one of treatment modalities in traditional Chinese Medicine and has been in clinical use for various illness (Tham, Lee, & Lu, 2006). The technique is based on negative pressure generated by suction of air using caps on the skin. In recent years, cupping therapy has been widely used in musculoskeletal disorders with good results (Cramer et al., 2011; Kim et al., 2012; Lauche et al., 2011; Markowski et al., 2013). The study of cupping therapy applied for football players with painful trigger points in the lumbar area of the spine revealed an immediate reduction in pain and pressure sensitivity (Fousekis et al., 2016).—Moreover, clinical study of cupping therapy on chronic fatigue syndrome shows the significant results of fatigue symptom reduction as well as the improvements of emotion and sleep conditions (X. D. Meng et al., 2020).

Massage is a therapeutic technique which applies pressure and mobilizing along anatomical structures of the body. The performance of massage on athletes that aims to rehabilitate or treat pathology is called sport massage (Benjamin & Tappan, 2005). Numerous studies of massage

for sport indicate that it helps to alleviate pain and fatigue; promote relaxation and attentiveness; improve mobility of joint and soft tissue as well as reduce anxiety (Boguszewski, Szkoda, Adamczyk, & Białoszewski, 2014).

On the psychological perspective, cupping therapy and massage have an important effect on the mood which is defended as a long-lasting emotional effect (Afsharnezhad & Khaleghi, 2022; Micklewright, Griffin, Gladwell, & Beneke, 2005). The profile of mood states (POMS) is one of the often used tool in sport research. There are six common mood states including depression, tension, anger, confusion, fatigue and vigor (Beedie, Terry, & Lane, 2000). This tool is worth pointing out the mood state of the athlete because positive mental state and reduction of fatigue are the factors influencing the performance of the athlete.

Taken together, the use of cupping therapy and massage for sport rehabilitation made it interesting for clinical study in the professional football players. In this research, blood lactate concentration and heart rate were selected as the most often measured parameters for fatigue of athletes (Goodwin, Harris, Hernández, & Gladden, 2007). Profile of Mood States (POMS) questionnaire (McNair, 1992) was used to investigate the psychological state.

Method

Participants

Fifteen male professional football players (mean ± S.D. for age, height, body weight are 21.85 ± 3.67yrs., 69.91 ± 9.97 kg., 174.00 ± 5.90 cm., respectively), with no severe illness as well as injuries of muscle and joints at lower limbs at least 6 months before the initiation of the experiment. The study was approved by Human Research Ethics Committee of Chiang Rai Provincial Public Health Office, Thailand. All participants signed the informed consents and the study were informed prior to the experiment.

Intervention and procedure

This study adopted a randomized crossover design. The setting was at the Star Power Training stadium, Chiang Rai City Football Club. The sequence of intervention was determined by the randomization order and was concealed in an opaque envelope until commencement of the study. Data collection and entry were performed by another investigator who was blinded to the intervention. The design is outlined in figure 1. Upon the arrival at the stadium, participants were randomly assigned to each group and were not informed as which group they were assigned. Prior to the physical activity, each participant rested in the sitting position for 5 minutes. Then each participant completed 400 m trails at maximum speed, followed by 15-minute recovery interventions (massage, rest or cupping therapy). Blood lactase and heart rate were measured immediately after the physical activity and at 5, 10, 20 min. after that, participants were then introduced to complete POMS questionnaire. This sequence was repeated similarly, except the recovery interventions giving in each session. There were three sessions of the interventions.

Massage

The selective technique of massage was the deep stroking technique. The participants were positioned in prone lying with knee in full extension. The posterior aspect of the thigh was exposed. The therapist who passed a sport massage course before the interventions performed deep stroking for 5 minutes on both hamstring and calf, then performed deep stroking for 5 min on upper and lower back, lastly changed the position to supine lying and performed deep stroking for 5 minutes on both quadriceps.

Cupping therapy

Ten glass cups (5 cm. outer diameter) were used for cupping therapy and the cups were placed at both sides of paravertebral area (T1-L4 level). This study applied with fire cupping technique Briefly, heating inside of the glass cup with a flame to create a vacuum. The application time

was 15 minutes then remove the cup by gently pressing the skin at the rim of cup, thus the pressure is released slowly and the cup can be removed easily.

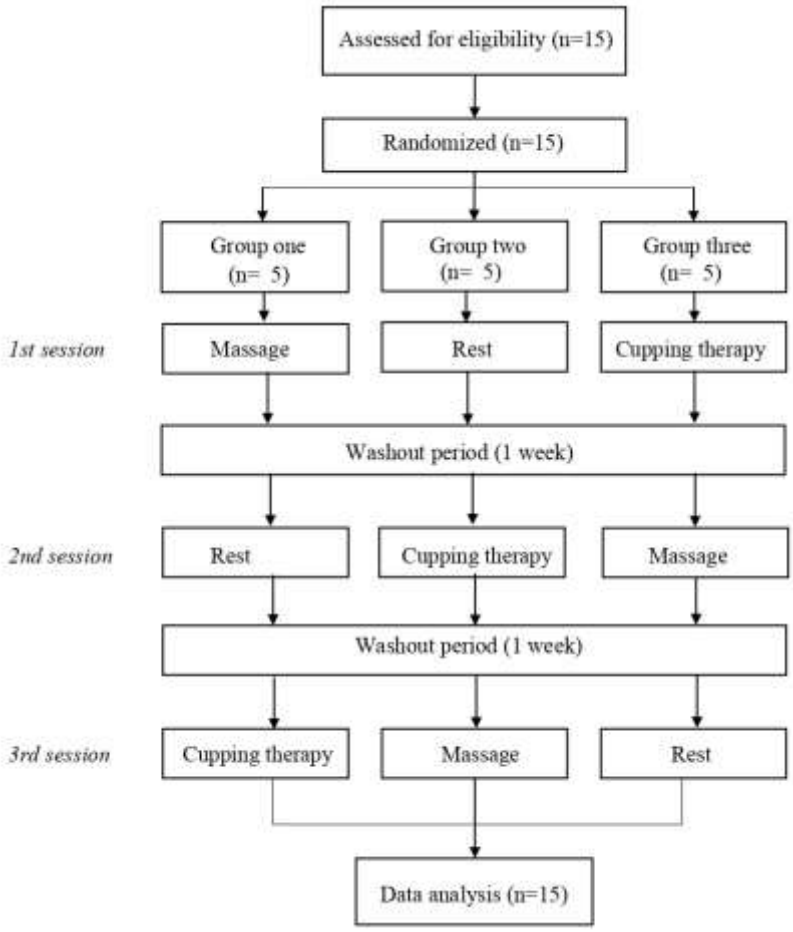

Figure 1. Participant flow through the study.

Measures

Blood lactate evaluation. Fingertip was punctured by using a lancet to collect capillary blood samples (0.2 µL). Blood lactate measurement utilized lactate Scout portable lactate analyzer. After post-recovery intervention, the blood lactate was measured at 4 time points: baseline and 5, 10, 20 min.

Heart rate evaluation. The heart rate chest strap monitor (POLAR H10 Heart Rate Monitor) was placed directly on the skin, below the sternum. After post-recovery intervention, the heart rate was measured at 4 time points: baseline and 5, 10, 20 min.

Mood states. Profile of mood states (POMS) questionnaire consisting of 65 questions describing six mood dimensions (McNair, Lorr, & Droppleman, 1971) was used to determine how participants were feeling after received the recovery interventions in each session. Participant was required to rate the level at which they felt that way according to a five-point Likert scale, with 0 being “not at all” and 4 being “extremely”.

Data analysis

Descriptive statistics to analyze general data such mean, standard deviation, frequencies and percentage. The One-Way Repeated Measures

ANOVA was used to analyze the mean different of experimental tests. The least significant difference (LSD) test were used for between-intervention comparison at a post-recovery time point. A p-value of < 0.05 was considered statistically significant. All statistical tests were analyzed using the Statistical Sciences(SPSS) Version 13.0 (SPSS Inc., USA).

Results

A total of 15 professional football athletes participated in the study. All recruited participants completed the trial and there was no report of adverse effects associated with the data collection process.

Blood lactate clearance and heart rate post-recovery

Levels of blood lactate and heart rate measured immediately after exercise and 5, 10, 20 min post-recovery are displayed and all results are expressed as mean ± S.D. in table 1. Blood lactate level were not significantly differences existed between any of the recovery treatment at 0,5,10 min post-recovery. However, significant differences ($p<0.05$) of blood lactate were found at 20 min post-recovery (Figure 2). Blood lactate at 20 min after massage and cupping recovery were significantly lower than rest, a control group ($p<0.05$); whereas, no significant differences were found in blood lactate level at 20 min post-recovery between massage and cupping (Table1). There were no significant differences between recovery interventions on heart rate at 0 and 5 min post-recovery. However, significant differences ($p<0.05$) were found at 10 and 20 min post-recovery (Figure 3). Heart rate at 10 and 20 min after massage were significantly lower than the control group, while no significant differences were found between massage and cupping therapy (Table1).

Table 1 Blood lactate level and heart rate recorded post-recovery (n=15) (mean ± S.D.)

Variables	Post-recovery time (minutes)			
	0	5	10	20
Blood lactate (mmol/L)				
Rest	8.99±3.54	7.29±3.32	6.90±3.26	6.36±3.16
Massage	8.87±3.27	7.71±3.71	4.97±2.05	3.98±1.64*
Cupping	7.94±4.37	6.70±3.94	4.62±2.50	3.35±1.86*
Heart rate (beat per min)				
Rest	100.14±13.64	95.79±12.15	94.71±11.12	90.64±9.83
Massage	106.00±10.35	95.07±11.85	85.29±9.22*	79.29±5.74*
Cupping	100.50±16.04	94.36±16.60	85.36±11.15*	79.79±10.45*

* Values are significantly difference from rest values ($p<0.05$).

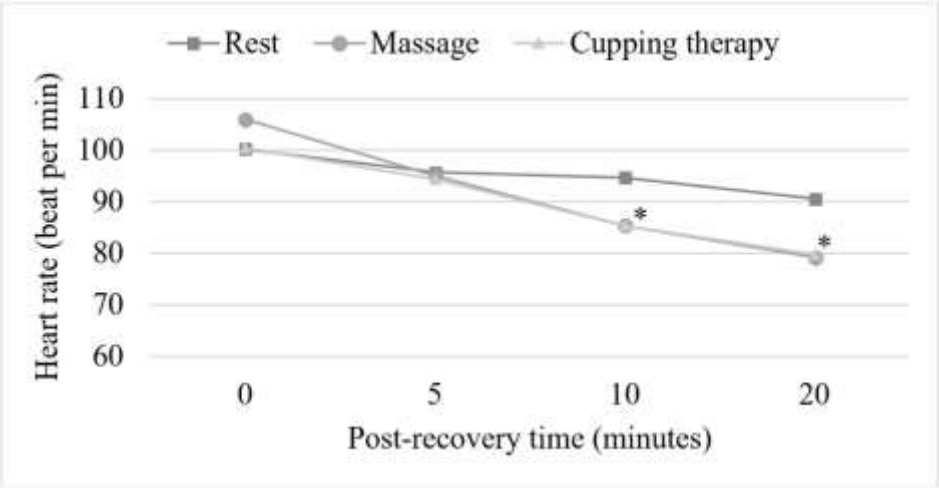

Figure 2. Blood lactate post-recovery

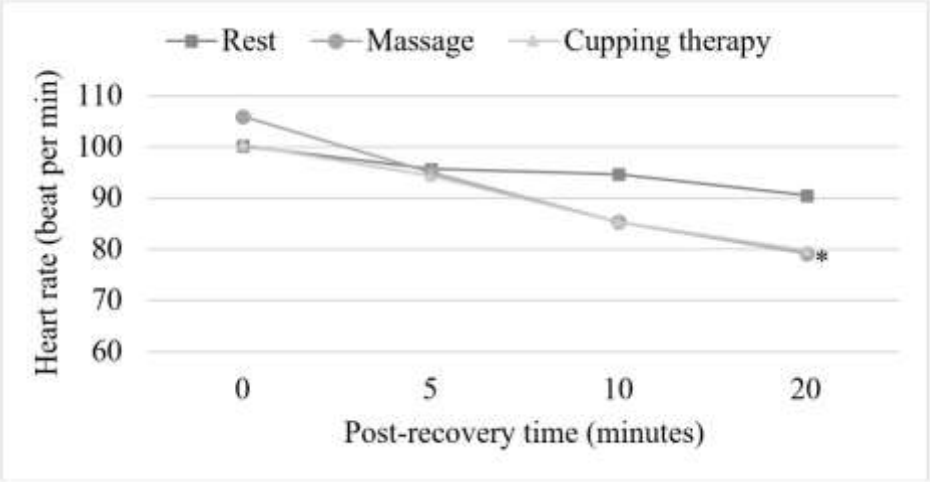

Figure 3. Heart rate post-recovery

Profile of mood states

The scores of six distinct dimensions of mood obtained from the Profile of Mood States (POMS) questionnaire after post-recovery are displayed in figure 4. No significance was found for rest, massage and cupping therapy. However, the scores of vigor, a positive mood state in massage and cupping therapy groups are higher than that of rest. The negative mood states including tension, depression and fatigue are also lower than that of rest after post-recovery.

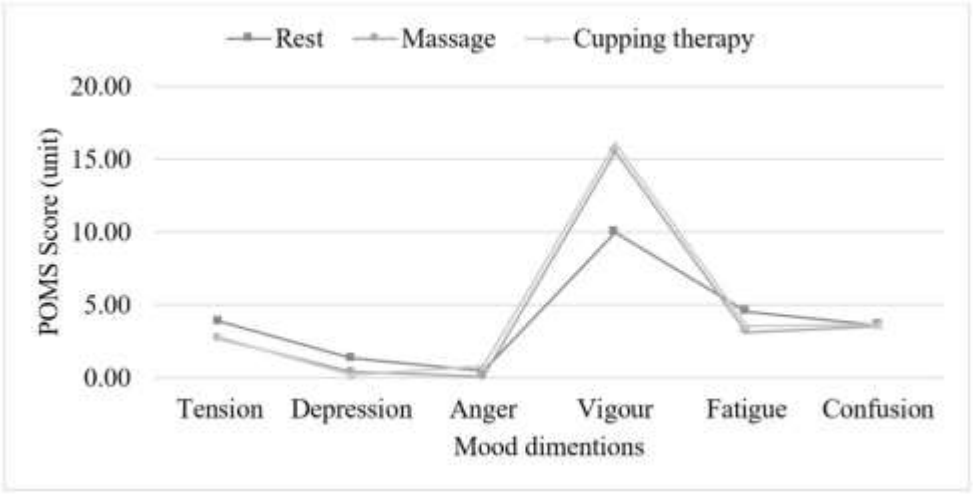

Figure 4. Profile of Mood States (POMS) scores post-recovery

Discussion

The emerge of utilizing complementary and alternative medicine in sport is experiencing a growing popularity worldwide (Kent, Tanabe, Muthusubramanian, Statuta, & MacKnight, 2020). In Thailand, soft tissue manipulation using massage and cupping therapy is integrated into the dominant health care system (Donnapee, Wongpim, & Chuthaputti, 2021). Globally, these manipulations are famous among treatment and rehabilitation of the athletes (Mylonas, Angelopoulos, Tsepis, Billis, & Fousekis, 2021). Therefore, the purpose of the present study is to determine if massage and cupping therapy effected blood lactate clearance, heart rate and mood state in professional football athletes. The principal findings in this study were that massage and cupping therapy as post-recovery treatments caused a significant increase in blood lactate clearance and reducing heart rate compared to rest. Slightly effect on mood state was found; however, there was no statistically significant difference between rest, massage and cupping therapy.

Previous studies have shown that cupping therapy acts to improve muscle stiffness (Jan et al.,2021), relieve muscle pain (Jan et al., 2021) and increase local blood flow (Hou et al., 2021; Wang et al., 2020). The increase in blood flow may promote the disposal of toxins and wastes, improve local nutrition state, boost metabolism, and support the removal of toxic substances from the affected area where the cups are applied (Al-Qaoud, 2013). This explains the body relieving toxins and harmful materials through the underlying mechanism of cupping therapy. Therefore, it is assumed that cupping has benefit to improve blood lactate. From the view of physics, cupping which uses negative pressure for suction benefits the extraction of toxins.However, the studies of cupping effect of lactic acid reduction were very few and the results were very conflicting (Almaiman, 2018; Mohammad-Khalil, Mohsen, Laleh, Saeid, & Khadijeh, 2016). Recovery from exercise can be supported by mechanically compressing techniques on tissues to induce vasodilation and increase blood circulation (Dupuy, Douzi, Theurot, Bosquet, & Dugué, 2018). In the same manner of cupping therapy, many studies demonstrated that massage increased skin and intramuscular blood flow (Hansen & Kristensen, 1973; Hovind & Nielsen, 1974; Mori et al., 2004); however, the results of reducing lactic acid by massage were very conflicting. In the previous study, massage was used as a post-recovery intervention compared to rest for anaerobic exercise (200 meters run). The study was found that a 15 minute massage on lower limbs showed a significant difference ($p<0.000$) to reduce lactic acid levels (Sari, Harahap, Siregar, & Rispandi, 2019). The result of this research shows that the experimental groups (massage and cupping therapy) have better lactate excretion than the control group (rest). Therefore,

manipulation related to blood flow could be used to explain the results of this research.

The reduction of heart rate after cupping therapy can be explained by neurophysiological mechanism of vasodilation and parasympathetic activation. Vasodilation during cupping causes muscle relaxation and will also stimulate parasympathetic activity. Blood flow enhancing mechanism of cupping can be explained using previous study, which shows that cupping therapy stimulate the endothelial cells to release vasodilators that will dilate local blood vessel of the skin (Al-Bedah et al., 2018). For addition negative pressure from cupping therapy will also stimulate peripheral nerve and autonomic nervous system and this mechanism is call somato-visceral reflexes, which control working balance of internal organ, such as heart rate (Sato, 1997). The tendency of increasing the parasympathetic activity and relaxing of the body muscles could be caused by loss of blood and vasodilation. There are claims that cupping was found to improve subcutaneous blood flow and stimulate the autonomic nervous system (Tang et al., 2019). Massage as a relaxing modality exhibited favorable results for recovery in cardiovascular markers, such as heart rate and blood pressure reductions in the post-exercise period (Diego & Field, 2009; Kubsch, Neveau, & Vandertie, 2000). Results of the present study were consistent with the study of leg massage compared to active and passive recovery modes (Desalegn & Verma, 2007). The study has been shown to contribute positively results with better heart-rate recovery (reducing the heart rate) and improving blood pressure in football players after received massage as post recovery intervention.

The profile of mood states has been widely used to investigate the effect of exercise on mood in sport psychology research (Lochbaum, Zanatta, Kirschling, & May, 2021). Positive mood state has long been thought to play an important role in sport performance. The athletes may have similar physical skills; however, the players who have higher psychological skills will gain more advantage over their opponents. (Hassmén & Blomstrand, 1995). In this study, no significance was found for rest, massage and cupping therapy in mood state; however, the raw data of positive mood state (vigor) was higher in massage and cupping therapy groups compared to rest. Additionally, raw data of three negative mood states (depression, fatigue and tension) were found to be lower in massage and cupping therapy groups. Similar effects were confirmed in a previous research of 10 min of cupping therapy as a post-recovery treatment on mood states of athletes. The results exhibited the reduction in negative mood states (fatigue, tension, depression, confusion, and anger): whereas, positive mood states (vigor) was increased after the session of cupping therapy (Afsharnezhad & Khaleghi, 2022). Another clinical study of cupping therapy on chronic fatigue syndrome also revealed that cupping therapy relieved fatigue symptoms, evaluating by Fatigue Scale (FS-14) score; however, there were no statistical differences in Fatigue Assessment Instrument (FAI) score after 5 and 10 sessions (Xiu Dong Meng et al., 2020). Moreover, the study suggested that session of cupping influenced the effective of cupping therapy.

Conclusion

Application of massage and cupping therapy as post-recovery treatments after anaerobic physical exercise in professional football players have effects on decreasing lactic acid levels and heart rate. Unfortunately, such effects are not attributable to significantly changes in mood state compared to rest. Future research should investigate in large sample size for better outcome. It would be beneficial to vary the time of massage and cupping therapy or look at the POMS at more frequent time points for better outcome in mood state.

Declaration of Conflicting Interests

The authors declared no conflicts of interest with respect to the research, authorship, and/or publication of this articles.

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References

[1] Afsharnezhad, T., & Khaleghi, M. (2022). Effect of Dry Cupping on Muscle Strength, Anaerobic Power, Cognitive Function and Mood States of Athletes. *Complementary Medicine Journal, 11*, 268-279. doi:10.32598/cmja.11.3.1085.1

[2] Al-Bedah, A. M. N., Elsubai, I. S., Qureshi, N. A., Aboushanab, T. S., Ali, G. I. M., El-Olemy, A. T., . . . Alqaed, M. S. (2018). The medical perspective of cupping therapy: Effects and mechanisms of action. *Journal of traditional and complementary medicine, 9*(2), 90-97. doi:10.1016/j.jtcme.2018.03.003

[3] Al-Qaoud, K. (2013). Investigation of Selected Immunocytogenetic Effects of Wet Cupping in Healthy Men. *Open Access ORIGINAL RESEARCH Spatula DD, 3*, 51-57. doi:10.5455/spatula.20130712050838

[4] Allmers, S., & Maennig, W. (2009). Economic Impacts of the FIFA Soccer World Cups in France 1998, Germany 2006, and Outlook for South Africa 2010. *Eastern Economic Journal, 35*(4), 500-519. Retrieved from http://www.jstor.org/stable/40326165

[5] Almaiman, A. A. (2018). Proteomic effects of wet cupping (Al-hijamah). *Saudi Med J, 39*(1), 10-16. doi:10.15537/smj.2018.1.21212

[6] Beedie, C. J., Terry, P. C., & Lane, A. M. (2000). The profile of mood states and athletic performance: Two meta-analyses. *Journal of Applied Sport Psychology, 12*(1), 49-68. doi:10.1080/10413200008404213

[7] Benjamin, P. J., & Tappan, F. M. (2005). *Tappan's Handbook of Healing Massage Techniques: Classic, Holistic and Emerging Methods* (4th ed.). New Jersey: Prentice Hall.

[8] Boguszewski, D., Szkoda, S., Adamczyk, J. G., & Białoszewski, D. (2014). Sports massage therapy on the reduction of delayed onset muscle soreness of the quadriceps femoris. *Hum Mov., 15*(4), 234–237.

[9] Cramer, H., Lauche, R., Hohmann, C., Choi, K. E., Rampp, T., Musial, F., . . . Dobos, G. (2011). Randomized Controlled Trial of Pulsating Cupping (Pneumatic Pulsation Therapy) for Chronic Neck Pain. *Complementary Medicine Research, 18*(6), 327-334. doi:10.1159/000335294

[10] Desalegn, M., & Verma, S. (2007). Effect of Leg Massage on Recovery from High Intensity Exercise on Football Players. *Journal of Exercise Science & Physiotherapy, 3*, 120-128.

[11] Diego, M. A., & Field, T. (2009). Moderate pressure massage elicits a parasympathetic nervous system response. *Int J Neurosci, 119*(5), 630-638. doi:10.1080/00207450802329605

[12] Donnapee, S., Wongpim, K., & Chuthaputti, A. (2021). The regulation of Chinese medicine in Thailand. *Longhua Chinese Medicine, 4*. Retrieved from https://lcm.amegroups.com/article/view/7154

[13] Dupuy, O., Douzi, W., Theurot, D., Bosquet, L., & Dugué, B. (2018). An Evidence-Based Approach for Choosing Post-exercise Recovery Techniques to Reduce Markers of Muscle Damage, Soreness, Fatigue, and Inflammation: A Systematic Review With Meta-Analysis. *Front Physiol, 9*, 403. doi:10.3389/fphys.2018.00403

[14] Fousekis, K., Kounavi, E., Doriadis, S., Mylonas, K., Elias Kallistratos, E., & Tsepis, E. (2016). The effectiveness of instrument-Assisted soft tissue mobilization technique (Ergon? Technique), cupping and ischaemic pressure techniques in the treatment of amateur athletesÎ myofascial trigger points. *J Nov Physiother, 3*. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85045336705&partnerID=40&md5=f2ea8df188280b034452c838d541b1d9

[15] Goodwin, M. L., Harris, J. E., Hernández, A., & Gladden, L. B. (2007). Blood lactate measurements and analysis during exercise: a guide for clinicians. *Journal of diabetes science and technology, 1*(4), 558-569. doi:10.1177/193229680700100414

[16] Hansen, T. I., & Kristensen, J. H. (1973). Effect of massage, shortwave diathermy and ultrasound upon 133Xe disappearance rate from muscle and subcutaneous tissue in the human calf. *Scand J Rehabil Med, 5*(4), 179-182.

[17] Hassmén, P., & Blomstrand, E. (1995). Mood state relationships and soccer team performance. *The Sport Psychologist, 9*(3), 297-308.

[18] Hemmings, B. J. (2001). Physiological, psychological and performance effects of massage therapy in sport: a review of the literature. *Physical Therapy in Sport, 2*(4), 165-170. doi:https://doi.org/10.1054/ptsp.2001.0070

[19] Hou, X., He, X., Zhang, X., Liao, F., Hung, Y.-J., & Jan, Y.-K. (2021). Using laser Doppler flowmetry with wavelet analysis to study skin blood flow regulations after cupping therapy. *Skin Research and Technology, 27*(3), 393-399. doi:https://doi.org/10.1111/srt.12970

[20] Hovind, H., & Nielsen, S. L. (1974). Effect of massage on blood flow in skeletal muscle. *Scand J Rehabil Med, 6*(2), 74-77.

[21] Huertas, J. R., Casuso, R. A., Agustín, P. H., & Cogliati, S. (2019). Stay Fit, Stay Young: Mitochondria in Movement: The Role of Exercise in the New Mitochondrial Paradigm. *Oxidative Medicine and Cellular Longevity, 2019*, 7058350. doi:10.1155/2019/7058350

[22] Jan, Y. K., Hou, X., He, X., Guo, C., Jain, S., & Bleakney, A. (2021). Using Elastographic Ultrasound to Assess the Effect of Cupping Size of Cupping Therapy on Stiffness of Triceps Muscle. *Am J Phys Med Rehabil, 100*(7), 694-699. doi:10.1097/phm.0000000000001625

[23] Kent, J. B., Tanabe, K. O., Muthusubramanian, A., Statuta, S. M., & MacKnight, J. M. (2020). Complementary and Alternative Medicine Prescribing Practices Among Sports Medicine Providers. *Altern Ther Health Med, 26*(5), 28-32.

[24] Kim, T.-H., Kang, J. W., Kim, K. H., Lee, M. H., Kim, J. E., Kim, J.-H., . . . Hong, K. E. (2012). Cupping for Treating Neck Pain in Video Display Terminal (VDT) Users: A Randomized Controlled Pilot Trial. *Journal of Occupational Health, 54*(6), 416-426. doi:https://doi.org/10.1539/joh.12-0133-OA

[25] Kubsch, S. M., Neveau, T., & Vandertie, K. (2000). Effect of cutaneous stimulation on pain reduction in emergency department patients. *Complement Ther Nurs Midwifery, 6*(1), 25-32. doi:10.1054/ctnm.1999.0429

[26] Lauche, R., Cramer, H., Choi, K.-E., Rampp, T., Saha, F. J., Dobos, G. J., & Musial, F. (2011). The influence of a series of five dry cupping treatments on pain and mechanical thresholds in patients with chronic non-specific neck pain--a randomised controlled pilot study. *BMC complementary and alternative medicine, 11*, 63-63. doi:10.1186/1472-6882-11-63

[27] Lochbaum, M., Zanatta, T., Kirschling, D., & May, E. (2021). The Profile of Moods States and Athletic Performance: A Meta-Analysis of Published Studies. *European journal of investigation in health, psychology and education, 11*(1), 50-70. doi:10.3390/ejihpe11010005

[28] Markowski, A., Sanford, S., Pikowski, J., Fauvell, D., Cimino, D., & Caplan, S. (2013). A Pilot Study Analyzing the Effects of Chinese Cupping as an Adjunct Treatment for Patients with Subacute Low Back Pain on Relieving Pain, Improving Range of Motion, and Improving Function. *The Journal of Alternative and Complementary Medicine, 20*(2), 113-117. doi:10.1089/acm.2012.0769

[29] McNair, D. M. (1992). Profile of mood states. *Educational and industrial testing service*.

[30] McNair, D. M., Lorr, M., & Droppleman, L. F. (1971). Manual profile of mood states.

[31] Meng, X. D., Guo, H. R., Zhang, Q. Y., Li, X., Chen, Y., Li, M. Y., . . . Guo, Y. (2020). The effectiveness of cupping therapy on chronic fatigue syndrome: A single-blind randomized controlled trial. *Complement Ther Clin Pract, 40*, 101210. doi:10.1016/j.ctcp.2020.101210

[32] Meng, X. D., Guo, H. r., Zhang, Q. Y., Li, X., Chen, Y., Li, M. Y., . . . Guo, Y. (2020). The effectiveness of cupping therapy on chronic fatigue syndrome: A single-blind randomized controlled trial. *Complementary Therapies in Clinical Practice, 40*, 101210.

doi:https://doi.org/10.1016/j.ctcp.2020.101210

[33] Metzger, J. M., & Moss, R. L. (1990). Effects of tension and stiffness due to reduced pH in mammalian fast- and slow-twitch skinned skeletal muscle fibres. *The Journal of physiology, 428*, 737-750. doi:10.1113/jphysiol.1990.sp018238

[34] Micklewright, D., Griffin, M., Gladwell, V., & Beneke, R. (2005). Mood State Response to Massage and Subsequent Exercise Performance. *The Sport Psychologist, 19*(3), 234-250. doi:10.1123/tsp.19.3.234

[35] Mohammad-Khalil, K.-S., Mohsen, G., Laleh, B., Saeid, E., & Khadijeh, O. (2016). The Effect of Cupping and One Exercise Session on Levels of Creatine Kinase and Lactate Dehydrogenase among the Members of a Handball Team. *Traditional and Integrative Medicine, 1*(3). Retrieved from https://jtim.tums.ac.ir/index.php/jtim/article/view/44

[36] Mori, H., Ohsawa, H., Tanaka, T. H., Taniwaki, E., Leisman, G., & Nishijo, K. (2004). Effect of massage on blood flow and muscle fatigue following isometric lumbar exercise. *Med Sci Monit, 10*(5), Cr173-178.

[37] Muangkram, Y., Honda, M., Amano, A., Himeno, Y., & Noma, A. (2020). Exploring the role of fatigue-related metabolite activity during high-intensity exercise using a simplified whole-body mathematical model. *Informatics in Medicine Unlocked, 19*, 100355. doi:https://doi.org/10.1016/j.imu.2020.100355

[38] Mylonas, K., Angelopoulos, P., Tsepis, E., Billis, E., & Fousekis, K. (2021). Soft-Tissue Techniques in Sports Injuries Prevention and Rehabilitation. In.

[39] Sari, R. M., Harahap, N. S., Siregar, N. S., & Rispandi, M. (2019). *The Effect of Massage to Decrease Lactic Acid Levels after Anaerobic Physical Activity*. Paper presented at the The 5th Annual International Seminar on Trends in Science and Science Education, Indonesia.

[40] Sato, A. (1997). Neural mechanisms of autonomic responses elicited by somatic sensory stimulation. *Neurosci Behav Physiol, 27*(5), 610-621. doi:10.1007/bf02463910

[41] Sporis, G., Ruzic, L., & Leko, G. (2008). The Anaerobic Endurance of Elite Soccer Players Improved After a High-Intensity Training Intervention in the 8-Week Conditioning Program. *The Journal of Strength & Conditioning Research, 22*(2). Retrieved from https://journals.lww.com/nsca-jscr/Fulltext/2008/03000/The_Anaerobic_Endurance_of_Elite_Soccer_Players.32.aspx

[42] Tang, J. S., Lung, C. W., Lee, F. H., Chuang, C. C., Liau, B. Y., & Chen, C. L. (2019). *The influence of dry cupping of differing intensities on heart rate variability.* Paper presented at the Advances in Intelligent Systems and Computing.

[43] Tham, L. M., Lee, H. P., & Lu, C. (2006). Cupping: From a biomechanical perspective. *Journal of Biomechanics, 39*(12), 2183-2193. doi:https://doi.org/10.1016/j.jbiomech.2005.06.027

[44] Wang, X., Zhang, X., Elliott, J., Liao, F., Tao, J., & Jan, Y.-K. (2020). Effect of Pressures and Durations of Cupping Therapy on Skin Blood Flow Responses. *Frontiers in Bioengineering and Biotechnology, 8*. doi:10.3389/fbioe.2020.608509