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A Network Meta-analysis Comparing Traditional Acupuncture Points and Ashi-points: Dealyed Onset Muscle Soreness

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A NETWORK META-ANALYSIS COMPARING TRADITIONAL ACUPUNCTURE POINTS AND ASHI-POINTS: DELAYED ONSET MUSCLE SORENESS

YUFANG SHAO

38 pages

Delayed onset muscle soreness (DOMS) is a type of muscle injury that can occur following moderate-to-high intensity physical activity. More recently, acupuncture has been considered as an alternative treatment method for muscle injury, which includes DOMS. However, there have been no specific investigations into potential differences when using traditional acupuncture (points based on traditional Chinese medicine theory), Ashi-acupuncture (points not on Chinese meridian, also known as tender points), or sham-acupuncture (superficial points, or points neither on the Chinese meridian nor the tender points) for treatment of DOMS. **PURPOSE**: To investigate the effectiveness of acupuncture treatment with traditional acupoints, Ashi points, and sham acupuncture to treat exercise-induced DOMS. **METHODS**: Data collected through November 2023 were reviewed, sourced from three digital databases. The study focused on reviewing the acupuncture points selection and location and treatment methods, pain measured on a visual analog scale (VAS) right after intervention was set as outcome. Data was compiled and evaluated using meta-analyses. **RESULTS**: A total of six articles were included. The results showed that there were no significant differences between VAS for all groups (all $p>0.05$). The standardized mean difference (SMD) of the VAS right after treatment between traditional acupuncture and the Ashi-points was 0.72 (95% CI: -7.6: 9.0). Similarly, comparisons of traditional acupuncture and other needle treatments (SMD=-1.3, 95%CI: -8. 0:, 4.7) and control groups (SMD = 1.9, 95%CI: -4.1: 8.3) were also not significantly different. **CONCLUSION**: Acupuncture was not an effective treatment for DOMS, regardless of use. Ashi, traditional, or sham acupuncture treatment.

KEYWORDS: Acupuncture, Delayed Onset muscle soreness, DOMS, Ashi-points, alternative treatment

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CHAPTER I: INTRODUCTION

Delayed Onset Muscle Soreness

Delayed Onset Muscle Soreness (DOMS) is a series of symptoms that occur after exercise in people who infrequently exercise or others who experience high-intensity training (Cheung et al., 2003; Hotfiel et al., 2018; Hume et al., 2004; Mizumura & Taguchi, 2016). Symptoms usually peak within 48-72 hours after exercise, with recovery in about five to seven days (Cheung et al., 2003; Hotfiel et al., 2018; Meng et al., 2017; O'Connor & Hurley, 2003; Zhong et al., 2022a). For most people, DOMS will recover by itself, but the symptoms of DOMS negatively impact the performance of athletes and recreationally active individual's life.

Symptoms of DOMS include pain, muscle tenderness, stiffness, loss of muscle strength, range of motion restriction, and swelling (Cheung et al., 2003). The factors of DOMS include but are not limited to rupture of muscle fibers, lactic acid accumulation, and muscle inflammation (Connolly et al., 2003; Gulick & Kimura, 1996; Hotfiel et al., 2018; Zhong et al., 2022b). In other words, the causes of DOMS are more complex than previously thought. Prevention and treatment of DOMS include adequate warm-up, stretching, freezing and pressure therapy, therapeutic exercise, and alternative therapies, such as acupuncture, instrument assisted soft tissue mobilization (IASTM), massage, etc. (Connolly et al., 2003; Heiss et al., 2019; Hume et al., 2004; Lewis et al., 2012).

Acupuncture

Acupuncture is the rooted in traditional Chinese medicine with a history of thousands of years, but the development in the Western world was less than a hundred years ago.

Acupuncture is a treatment method in which sterile needles are inserted into the muscle after acupoint (needle location) selection and operation according to the Clean Needle Technique Manual Guideline. Research shows that acupuncture can stimulate the nerves and brain to achieve the effect of opiate-like analgesics (Lee et al., 2004; Ma, 2007a; Tsuei, 1996), which is why acupuncture has been used more and more as an alternative treatment for a large number of morbidities. In recent years, some studies have demonstrated that acupuncture may have a significant effect on improved musculoskeletal injuries (Fernández-Carnero et al., 2010; Lee et al., 2023; Sung et al., 2023; Wang et al., 2020; WHITE et al., 2004) .

Acupuncture & Delayed Onset muscle soreness

Since 2020, three meta-analyses have examined whether acupuncture can be used as an effective treatment for DOMS. Ko and Clarkson (2020) systematically analyzed five random clinical trials (RCTs) and showed that after analyzing acupuncture and DOMS, it is unclear whether it has any efficacy. Chen et al. (2020) studied six RCTs studies, measuring conditions including muscle soreness rating (MSR), creatine kinase, and maximal isometric force, and found acupuncture led to a significant improvement in serum creatine kinase and muscle pain, and the effect of acupuncture on DOMS reached the maximum effect after 72 hours. Lastly, Huang et al. (2020) examined 15 RCTs articles and the results showed that acupuncture had a small effect on improving DOMS symptoms.

Objectives

The purpose is to analyze the relationship between acupuncture and DOMS, as the utility of acupuncture for DOMS is still ambiguous based on previous research, and to

investigate the effectiveness of traditional acupuncture points, A-shi (trigger) points, and non-traditional acupuncture and non-Ashi points for DOMS. We hypothesize that traditional acupuncture points will be more effective than A-shi points, and non-traditional and non-ashi points groups for the treatment of DOMS.

Research Question and Hypothesis. Does traditional acupuncture points treatment improve delayed-onset muscle soreness than Ashi-points treatment, non-ashi/ non-acupoints treatment, and the control group? The primary outcome measures were the VAS, and PPT right after treatment, 24 hours after treatment, and 48 hours after treatment.

RQ: Is there a statistically significant difference on the traditional acupuncture points improve DOMS than other needles treatments (Ashi-points, and non-ashi/ non-acu points) with VAS and PPT scale? If so, how is the difference between treatments.

H_o: There is not a statistically significant difference between traditional acupuncture points, ashi points, and non-ashi/ non-acu points, and the control group for improve DOMS with VAS, and PPT right after treatments, 24 hours later, and 48 hours later in the existing research.

H_a: There is a statistically significant difference between traditional acupuncture points, ashi points, non-ashi/ non-acu points, and the control group for improve DOMS with VAS, and PPT right after treatments, 24 hours later, and 48 hours later.

Methods

Eligibility Criteria

Before November 2023, a review of existing literature was conducted. This review focused on English-language studies that reported the effects of traditional or ashi acupuncture in treating delayed-onset muscle soreness. The inclusion criteria were limited to peer-reviewed, randomized controlled trials (RCTs) that exclusively examined the efficacy of acupuncture without incorporating additional treatments like moxibustion, Tui na, cupping, foam rolling, etc... Acupuncture points were required to adhere to clear and standardized traditional Chinese medicine (TCM) meridian definitions. However, the characterization of Ashi points varied across studies. For this meta-analysis, any references to needle points as trigger points, tender points, or ashi points, excluding dry needling and points outside of traditional acupuncture, were classified as ashi points. The placebo points or sham acupuncture points, which are not acupoints or do not match with ashi points, would be defined as non-ashi/ non-acu points (Others). Studies that described the use of dry needling, and laser acupuncture, or included additional interventions such as cupping or massage were excluded. Within this research, acupuncture points are specified as locations on the traditional acupuncture meridians, including forty-eight extra acupuncture points defined by World Health Organization (WHO) and National Certification Commission for acupuncture and oriental medicine (NCCAOM).

Exclusion criteria

Studies were excluded when the treatment integrated traditional acupuncture points with Ashi points, studies that were not randomized controlled trials (RCTs), unrelated to the

topic, duplicates, or those available only as abstracts without accessible full texts. Additionally, studies combining the treatment with other interventions or lacking visual analogue scale (VAS) or pain pressure threshold (PPT) measurements were also omitted from this research. All units were standardized to enable effective measurement and comparison. Information Sources and Electronic Search Strategies

Studies for potential inclusion were identified by searching the following electronic databases: PubMed, Google Scholar, and Cochrane. To broaden the range of studies beyond what was covered in previous reviews, and to prevent biases from limited search strategies, two approaches were utilized: searching through electronic databases and manual author-specific searches. The search terms used included those related to delayed-onset muscle soreness (e.g., 'delayed-onset muscle soreness*', 'DOMS*', 'muscle fatigue*', 'muscle pain*', 'muscle soreness*') and acupuncture (e.g., 'acupuncture*', 'traditional Chinese acupuncture*', 'Ashi points*', 'traditional Chinese medicine*')—searches targeting eligible studies for corresponding authors with computerized. Despite being time-consuming, these varied and thorough search steps are essential because a singular approach cannot uncover all pertinent studies, and the likelihood of bias differs across various search strategies.

Study Selection

A multi-step approach was adopted for selecting studies to be included in this meta-analysis, to ensure all relevant and all potential studies were comprehensively covered. Firstly, titles and abstracts were screened for indicators that suggested a study might meet the eligibility criteria. Following this preliminary review, full-text articles were scrutinized to verify

the inclusion of acupuncture points, ashi points, or points not classified as either acu or ashi. Subsequently, the identified studies were further assessed for relevant outcomes (such as VAS, and PPT) pertinent to the main study. Next, the studies were categorized based on the method of point selection, including traditional acupuncture points, Ashi points, and neither traditional nor Ashi points. Finally, the selected primary studies underwent evaluation for their effectiveness concerning acupuncture, ashi, and non-ashi/non-acu points.

Primary data was predominantly sourced from research papers. In cases where eligible studies did not fully display data in tables or narrative forms, the authors were contacted via email, or information was retrieved from graphs with WebPlotDigitizer. Each paper included in the study underwent a bias risk evaluation following the criteria set by the Cochrane Handbook for Systematic Reviews of Interventions (Cochrane Collaboration, 2007). Additionally, to check for potential publication bias, the sizes of the study samples and the effect sizes were analyzed using a funnel plot technique (Borenstein et al., 2009).

There are four subject groups in this network meta-analysis – the traditional acupuncture group, the Ashi-points group, others (non-acupoints/ non-ash points), and the control groups. To examine the VAS and PPT after treatment, 24 hours, and 48 hours to see the effectiveness for the DOMS, and compare the efficiency with each group. If the articles are included but not with all groups that will do the network comparison.

Data Analysis

To address the research question, a network meta-analysis was performed using R studio to evaluate potential differences in the effectiveness of acupuncture points, Ashi points,

non-acupuncture and non-Ashi points, and control groups within the collected studies. This analysis included calculating the overall effect size and confidence intervals for each group of points to assess the distinctions directly and indirectly among them. If the confidence interval was included, it suggested no significant difference in effectiveness between acupuncture points, Ashi points, non-acupuncture/non-Ashi points, and the control group. Conversely, if the confidence interval did not include 0, it signified a statistically significant difference in the overall effect size between the groups.

Results

Overview of Included Studies

The research involved the utilization of Google Scholar, PubMed, and Cochrane databases, with each search organized by relevance. It was observed that Google Scholar began to yield irrelevant or non-English articles beyond the 30th page. To manage the search results to a feasible number, approximately 1000, a specific search term "acupuncture and delayed-onset muscle soreness" was employed from the outset to filter articles focusing on the main intervention of traditional acupuncture. The search concluded on the 50th page, revealing 28 relevant publications.

Out of 13,610 results returned, 90 studies appeared potentially suitable before reaching the cap of 50 pages. Subsequently, the term "Ashi-points and delayed-onset muscle soreness" was used to sift through articles discussing Ashi-points as an intervention, but none were found among the 37 results returned. The search process in both keyword groups uncovered numerous meta-analysis studies and studies involving laser acupuncture, dry needling, or a

combination of traditional acupuncture points and Ashi points for treatment. A broader search using "acupuncture and delayed-onset muscle soreness OR DOMS" in the title yielded no new articles. Additional searches based on the authors of identified articles also produced new findings, ultimately discovering no further articles.

In PubMed, a comprehensive search term was employed to find articles covering acupuncture, delayed-onset muscle soreness, Ashi points or trigger points, with content descriptions on traditional acupuncture points and delayed-onset muscle soreness. Applying filters for full text, free full text, and randomized controlled trials, 17 articles were found, albeit with 11 being duplicates. A subsequent author search returned no new results.

For Cochrane, an amalgamation of databases including PubMed, and Embase, a search with "acupuncture in Title Abstract Keyword AND delayed-onset muscle soreness" was conducted. This search identified 10 articles from 15 results, with all 10 being duplicates. A final author search, set to include articles mentioning both "acupuncture" and "DOMS," found no additional relevant articles.

In the end, 145 potential articles were identified, of which 21 articles were duplicated. After excluding the duplicated articles, 124 were screened, and all the abstracts were reviewed. At this point, 107 articles were excluded, and the remaining 17 articles were reviewed by following all the screening processes. 61 articles were excluded because did not match with the eligible criteria, or the intervention with the dry needle. 11 studies were excluded because the intervention combined with other treatments, the intervention was points combination. Or the outcomes did not include VAS or PPT. Overall, 54 trials derived from 6 articles were included in

this meta-analysis (See Table 1). 14 trials were included for VAS right after treatment comparison, 12 trials were included for VAS after treatments 24 hours, and 6 trials were included for VAS after treatment 48 hours. 9 trials were included for PPT right after treatment, and 9 trials were included for PPT after treatment 24 hours (See Figure 1.).

Visual Analog Scale (VAS)

Analyses were conducted to examine variations in the effectiveness of acupuncture in treating DOMS in VAS right after, 24 hours, and 48 hours. For VAS, 41 trials were derived from 5 publications investigating the acupuncture treatment, Ashi-points, or non-acu/ non-ashi points effectiveness for DOMS. Not all publications compare the investment directly, 1 study did not have traditional acupuncture group, 3 studies did not have Ashi-points group, 1 study did not have non-acu/ non-ashi-points group, within these, in this meta-analysis used indirectly comparison to obtain the results.

VAS right after

5 studies with 14 trials reported traditional acupuncture vs. Ashi-points or others, in VAS right after treatment for DOMS. In consistency results showed that there was no significant difference between traditional acupuncture, Ashi-points, others, and control groups. The mean for traditional acupuncture compared with Ashi-points was -0.71. Compared with traditional acupuncture, Ashi-points (M: 0.72; 95% CI: -7.6: 9) had no significant difference. Traditional acupuncture compared with others (M = -1.3; 95% CI: -8: 4.7) had no significant difference. And traditional acupuncture and control groups (M= 1.9; 95% CI: -4.1: 8.3) had no significant difference (See Figure 2.)

For inconsistencies, results showed that overall, there was no significant difference between traditional acupuncture, Ashi-points, others, and control groups. In node-splitting there was no significant differences between traditional acupuncture, Ashi-points, Others, and control groups. Overall, for the network compared reported traditional acupuncture vs Ashi-points did not significantly have difference (M=-0.71; 95% CI-9: 7.9) (See Figure 3 & Figure 4.)

VAS 24 hours after

12 trials after directly and indirectly compared reported that traditional acupuncture did not have significant difference between Ashi-points (M= 0.74; 95% CI: -9.4: 10), others (M=-1.6; 95% CI: -9.5: 5.4), and control groups (M=0.21; 95% CI: -7.6: 7). The mean between traditional acupuncture and Ashi-points was -0.69 (See Figure 5.).

For inconsistencies, results showed in node-splitting method for direct/ indirect comparison that traditional acupuncture vs. Ashi-points overall network did not have significantly different (M=-0.82; 95% CI: -10: 9.4) (See Figure 6 & Figure 7).

VAS 48 hours after

6 trials showed that there were no significantly difference when compared traditional acupuncture and Ashi-points (M=7.1, 95% CI: -9.2: 23), traditional acupuncture and others (M= -6.5; 95% CI: -24: 11), and traditional acupuncture and control groups (M= 9.9; 95 % CI: -6.1: 27). The mean between Ashi-points and traditional acupuncture was -7.07 (See Figure 8.).

There was no sufficient data for inconsistency comparison for VAS 48 hours after treatment.

Pain Pressure Threshold (PPT)

Analyses were conducted to examine variations in the effectiveness of acupuncture in treating DOMS in PPT right after, and 24 hours. For PPT, 18 trials were derived from 3 publications investigating the acupuncture treatment, Ashi-points, or non-acu/ non-ashi points effectiveness for DOMS. In PPT analysis, since no study had Ashi-points group in collected data for PPT, in this data-analysis that Ashi-points comparison would be take out from the PPT. Since the data in PPT all can directly compare that in PPT would not have inconsistent results.

PPT right after

9 trials (n=3/ each group) showed that there was no significant difference effectiveness between traditional acupuncture, others, and control group in DOMS. The mean was -1.5 and 95% CI was -4.5 to 1.3 when compared traditional acupuncture and others. The mean was -0.81 and 95% CI was -3.8 to 2 when compared traditional acupuncture and control groups (See Figure 9.).

PPT 24 hours after

9 studies, with each group comprising three subjects, found no significant variance in effectiveness among traditional acupuncture, other, and control groups for DOMS. The mean was -2.1 and 95% CI was -4.6 to 0.5 when compared traditional acupuncture and others. The mean was -2.3 and 95% CI was -4.9 to 0.29 when compared traditional acupuncture and control groups (See Figure 10.).

Discussion

This systematic review and network meta-analysis evaluated the efficacy of traditional acupuncture, Ashi-points, other needle treatments, and control groups in the treatment of DOMS, based on the VAS and PPT scales. Overall, traditional acupuncture did not demonstrate a significant difference in effectiveness compared to all other needle treatments in terms of VAS and PPT for DOMS. This result aligns with a previous meta-analysis, which indicated that traditional acupuncture did not offer a clear benefit for DOMS (Chang et al., 2020; Mogford SJ, 2008). Interestingly, besides traditional acupuncture, no other needle treatments demonstrated a clear advantage over control groups either. It's important to note that the absence of significant differences may be attributed to the small sample sizes of the included data and the limited number of studies.

The benefits of acupuncture have different mechanisms, and previous studies showed different outcome benefits for acupuncture for muscle disorders and DOMS. Previous studies indicated that acupuncture could reduce muscle pain, and pain disorders (Peng et al., 2016; Tsuei, 1996; Xu et al., 2003). Itoh et al. (2011) demonstrated that trigger points acupuncture was effective for DOMS, especially the points on the soreness muscles. This means trigger points had better function for DOMS recovery than acupoints treatment in their study. According to Antonassi et al. (2021), acupuncture benefits for DOMS or other muscle disorders may be due to increasing pain tolerance threshold and levels after acupuncture treatment. Moreover, Paulson et al. (2012) indicated that acupuncture active the sympathetic nervous system and increased the local blood flow, maybe helping DOMS improve because of the impact on the causes DOMS.

However, Barlas et al. (2000) demonstrated that, under the same conditions, acupuncture did not have any significant difference compared to placebo or control groups for DOMS based on VAS. Fleckenstein et al. (2015) also indicated that acupuncture treatment did not have any additional benefits for DOMS than placebo and the control groups in pain threshold, VAS, and range of motion (ROM). These different findings from previous studies may be the result of differences in acupoints selection and the treatment manipulation. Barlas et al. (2000) also stated that for the specific pain type, the treatment effectiveness may be based on the researchers' bias. The results of the current meta-analysis reflect these contrasting findings from previous research.

The results for VAS and PPT after treatment, and at 24 and 48 hours (PPT did not have a 48 hour contribution), comparing traditional acupuncture, Ashi-points, other treatments, and control groups, did not meet expectations and showed no significant differences. This may be attributed to the criteria and classification used in the present study. Herein, the acupuncture intervention was only with traditional acupoints, most previous studies used traditional acupoints combined with Ashi points as intervention groups (Hübscher et al., 2008; M. Yu et al., 2022). These findings align with previous studies, which indicated that for both the acupuncture group (including Ashi-points) and control groups, there was no significant difference or only minimal effectiveness. A possible explanation is that one of the causes of delayed-onset muscle soreness (DOMS) is muscle fiber damage. While acupuncture may help improve inflammation and neuro-pain disorders, it cannot directly repair broken muscle fibers. Therefore, given the pathological factors of DOMS, all needle treatments (including traditional acupuncture), may not offer significant benefit for DOMS.

Unfortunately, it would appear that additional research is needed that compares traditional acupoints with other forms of needle treatment for DOMS to conduct more insightful meta-analyses. Only 1 out of 6 publications included traditional acupuncture, Ashi-points, others, and a control group, other publications only included 3 of 4 or 2 of 4 interventions. One reason for the discrepancies between studies is that there is no standardized acupoints selection and different definitions of Ashi points existed in each study.

Limitations

This research was limited to studies available in published form, potentially leading to publication bias. Moreover, significant research conducted in languages other than English, such as Mandarin or French, might have been overlooked, as this study focused solely on English-language publications. Because traditional acupuncture originates in China, expanding our study to include other languages likely would have increased our sample size significantly. Additionally, the sheer diversity in definitions of acupoints and combinations of acupoints led to the exclusion of some trials from the analysis. The small number of trials included in the study may have been insufficient to counteract the effects of individual variations among participants, which could account for the lack of significant differences in some outcomes.

Lastly, this meta-analysis excludes data related to joint range of motion, muscle strength, and mechanical pain threshold, despite their discussion in several studies related to DOMS. However, the omission of these metrics from the analysis was due to the lack of sufficient data.

Recommendation for Future Research and Reporting

Future research should include a larger sample size to reduce the influence of individual differences on the outcomes. In addition, standardized acupoints selection and definition of Ashi points should be more clearly defined in research utilizing needle treatments. On the other hand, the treatment sessions also need to be standardized, the treatment sessions and time would also impact the function of improvement. Furthermore, to clearly the main factors for DOMS also will be the key points for effectiveness of acupuncture and other needle treatments of DOMS.

In conclusion, when evaluating traditional acupuncture against Ashi points, other methods, and control groups, its impact on alleviating DOMS pain was minimal, especially when contrasted with other methods and control groups. DOMS has many components and traditional acupuncture may not sufficiently target all these factors. Additionally, research comparing various acupuncture points may help better explain potential benefits in the future. However, at this time, the effectiveness of acupuncture in easing DOMS symptoms appears to be limited.

Table 1. Overview of impacted muscles and treatment protocols featured in the articles reviewed.

Author	Year	Affected muscles	Groups (n)	Acupuncture points	Treatment session
Barlas et al.	2000	Biceps brachii	Ashi-points (n=12)	Ashi points	5 mins; 1 time/ day; 5 days
			Others (n=12)	Sham acupuncture points	5 mins; 1 time/day; 5 days
			Control (n=12)	No intervention	No treatment
Itoh et al.	2008	Biceps brachii	Others (n=10)	Sham acupuncture points	10 mins; 1 time
			Control (n=10)	No intervention	No treatment
Silverio-Lopes et al.	2018	Dorsiflexion	Traditional acupuncture (n=16)	ST36	
			Others (n=14)	2 cun distal from ST36	
			Control (n=15)	No intervention	
Cardoso et al.	2019	Quadriceps	Traditional acupuncture (n=15)	LR3, ST34, ST36	5 insertions; 1 time
			Others (n=15)	Sham acupuncture points	5 insertions; 1 time
			Control (n=15)	No intervention	No treatment
Antonassi et al.	2020	Biceps brachii	Traditional acupuncture (n=10)	IG4, IG11, E36, VB34	20 mins; 1 time/ day; 3 sessions
			Others (n=10)	Placebo	20 mins; 1 time/ day; 3 sessions
			Control (n=10)	No intervention	No treatment

Figure 1. Article selection process

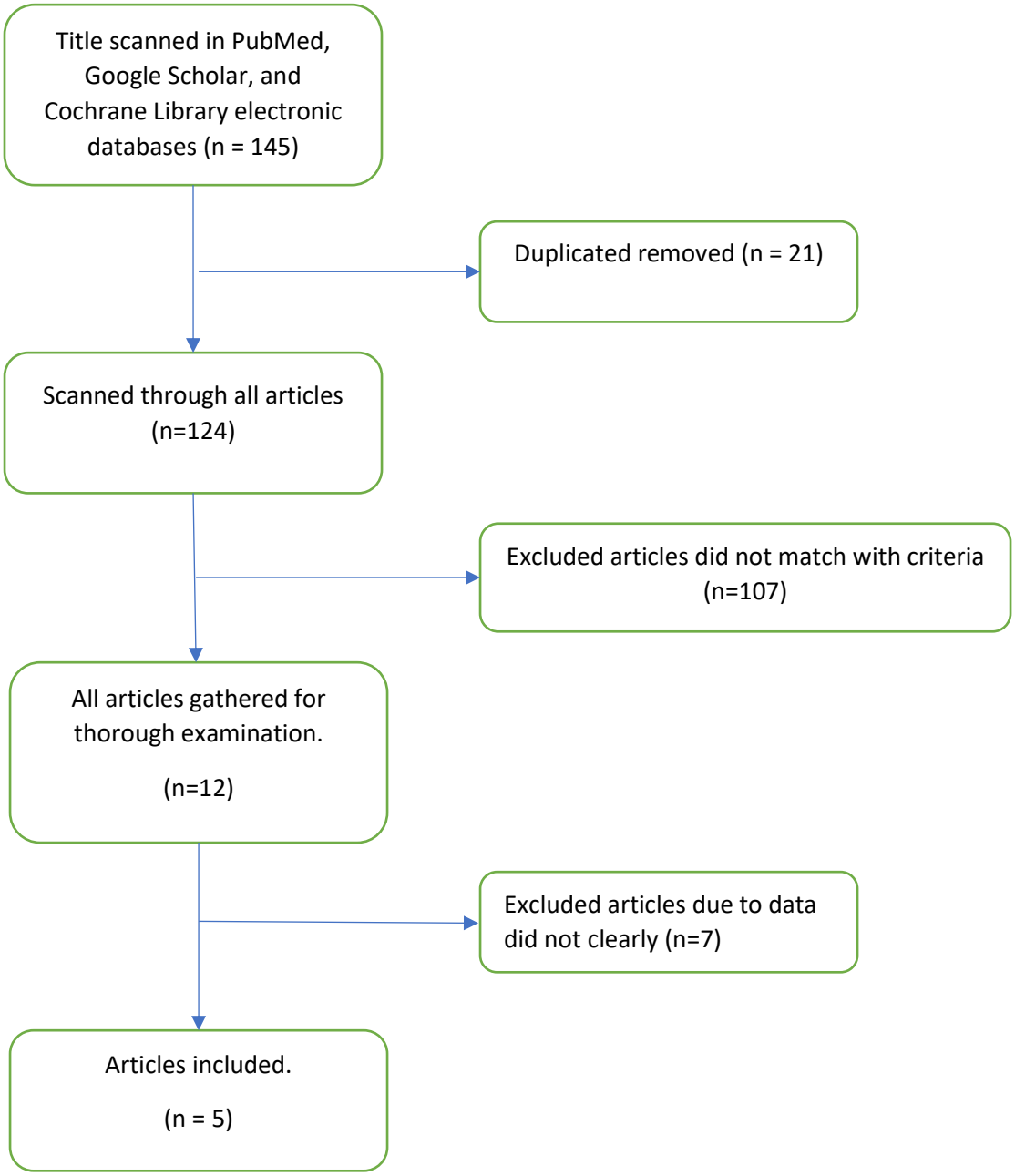


Figure 2. VAS after treatment

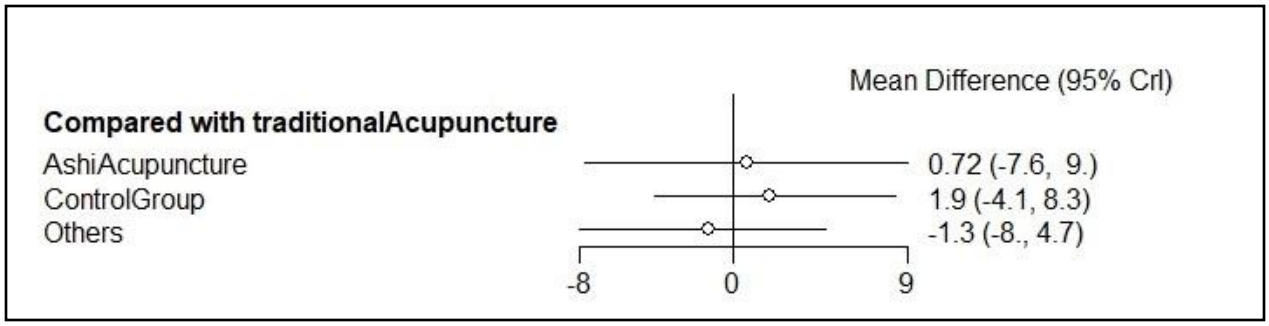


Figure 3. VAS after treatment network comparison

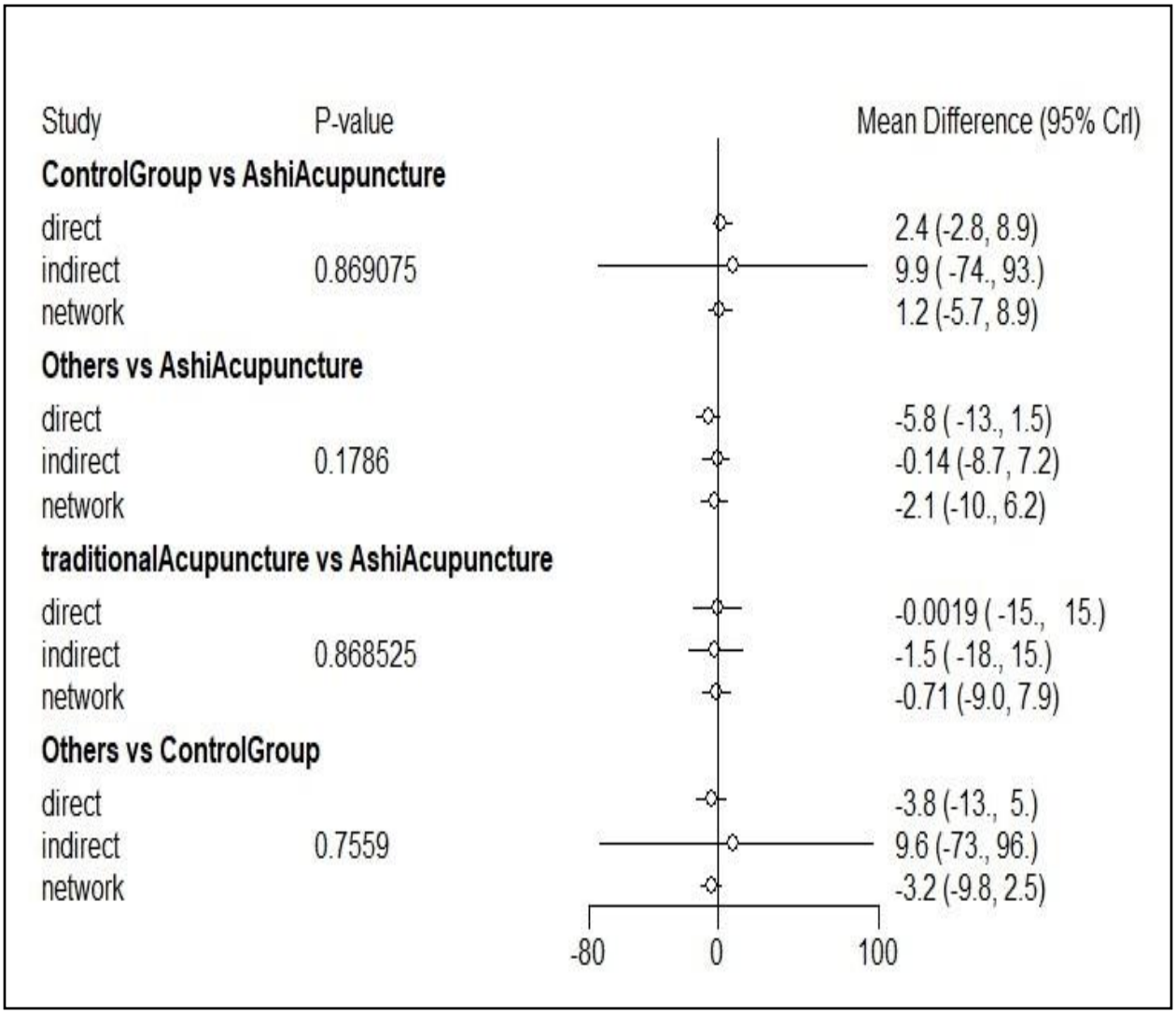
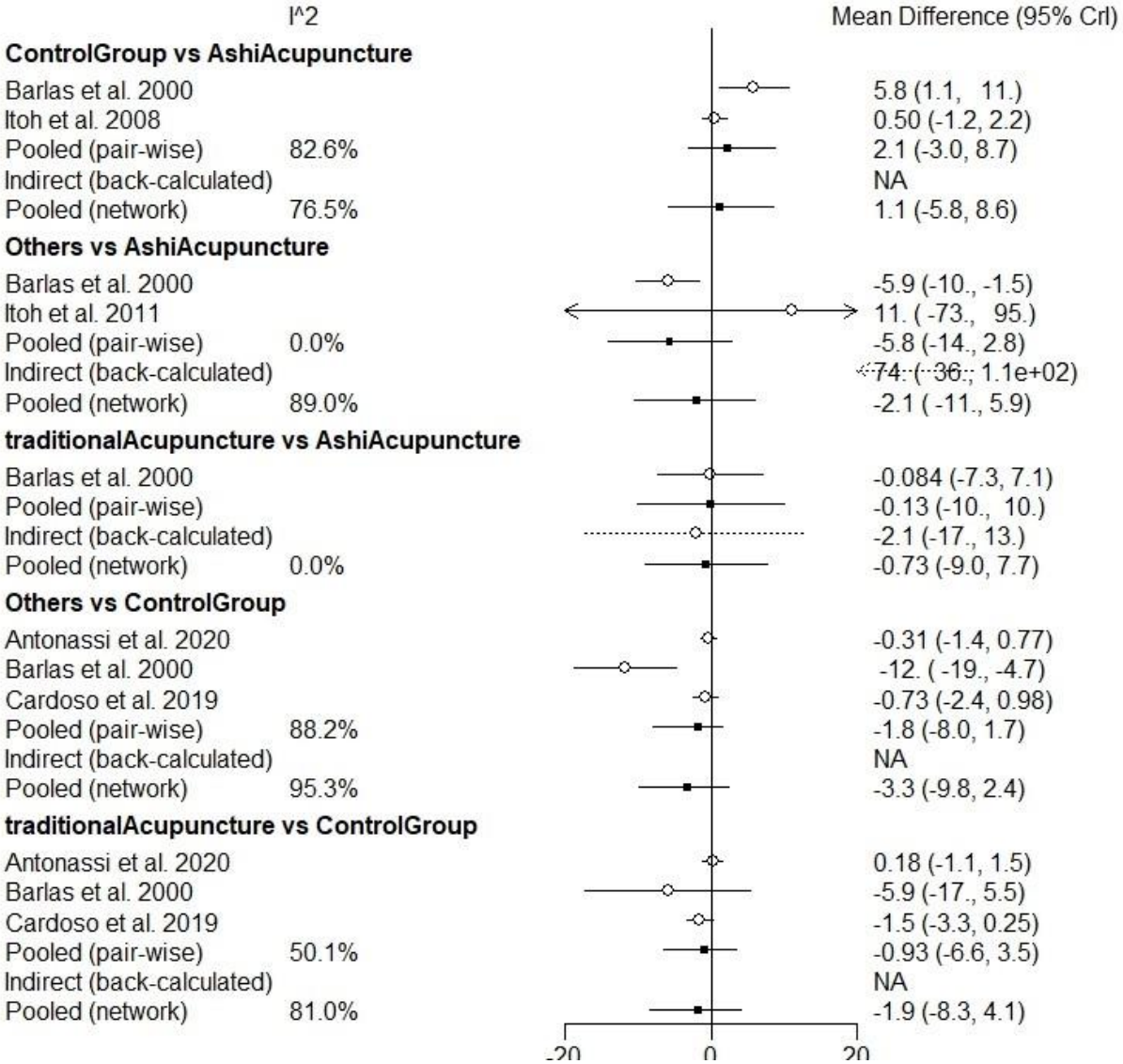


Figure 4. VAS after treatment splitnode comparison



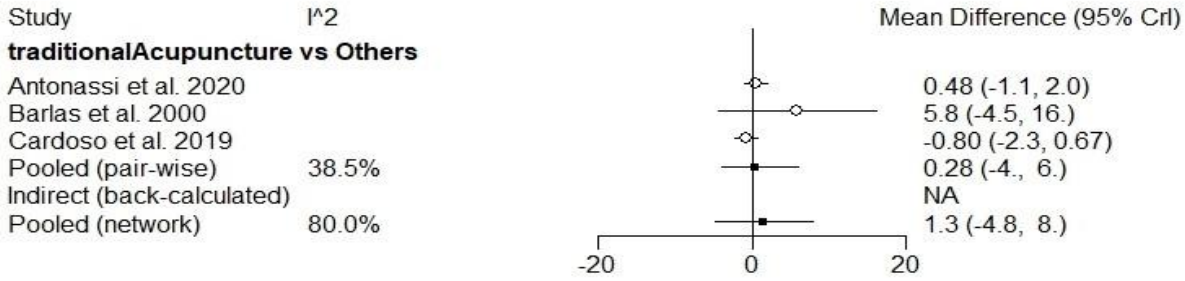


Figure 5. VAS 24 hours after treatment

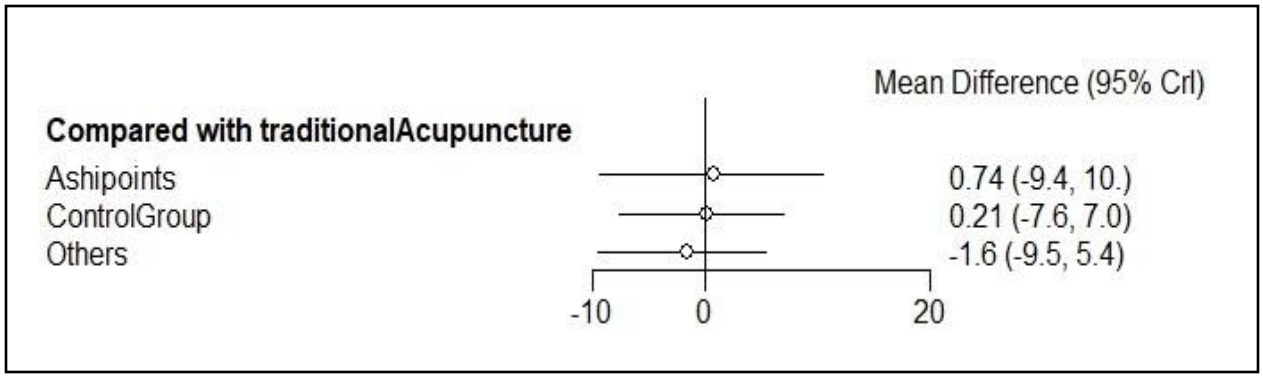


Figure 6. VAS 24 hours after treatment network comparison

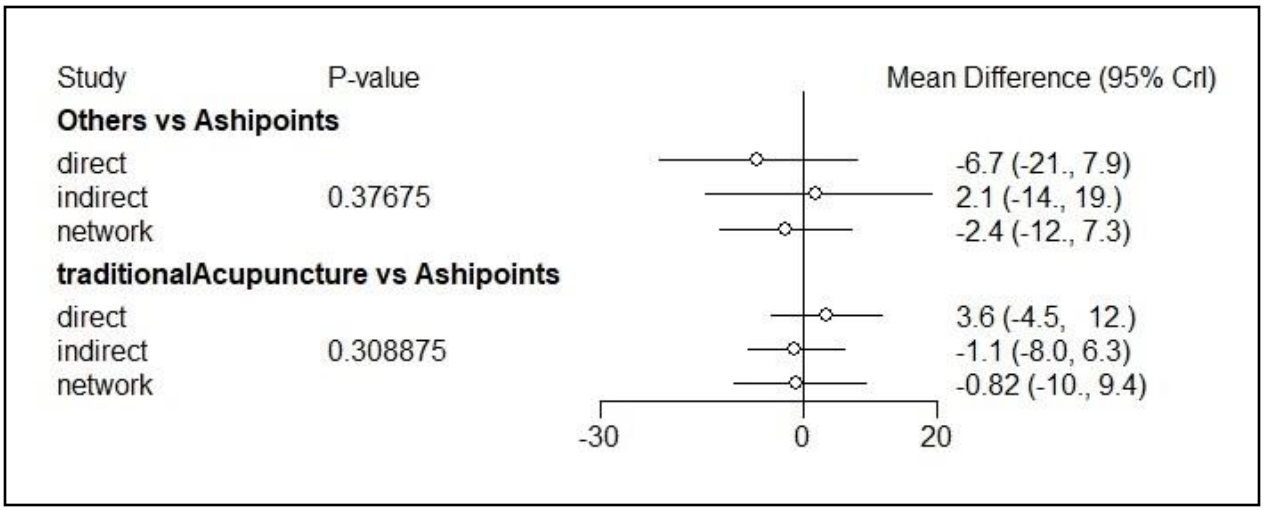


Figure 7. VAS 24 hours after treatment nodesplit

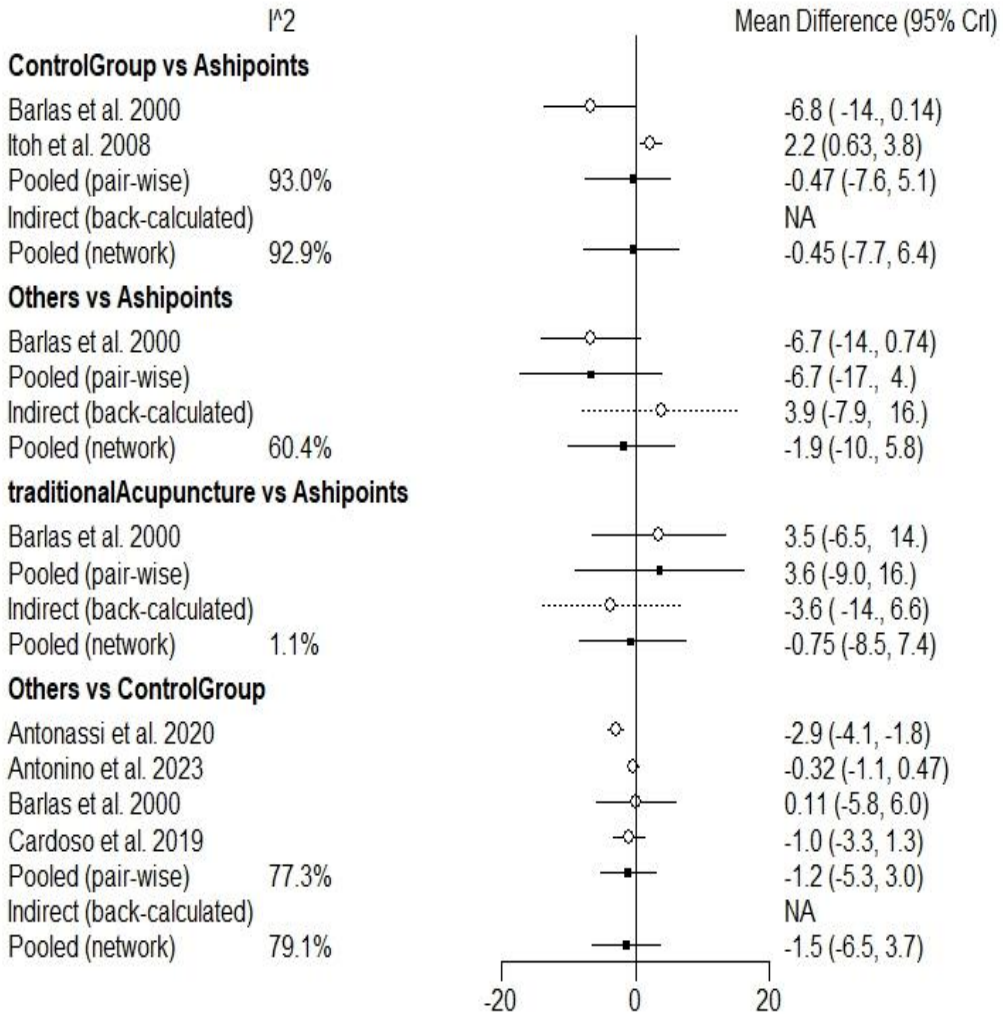


Figure 7. continue

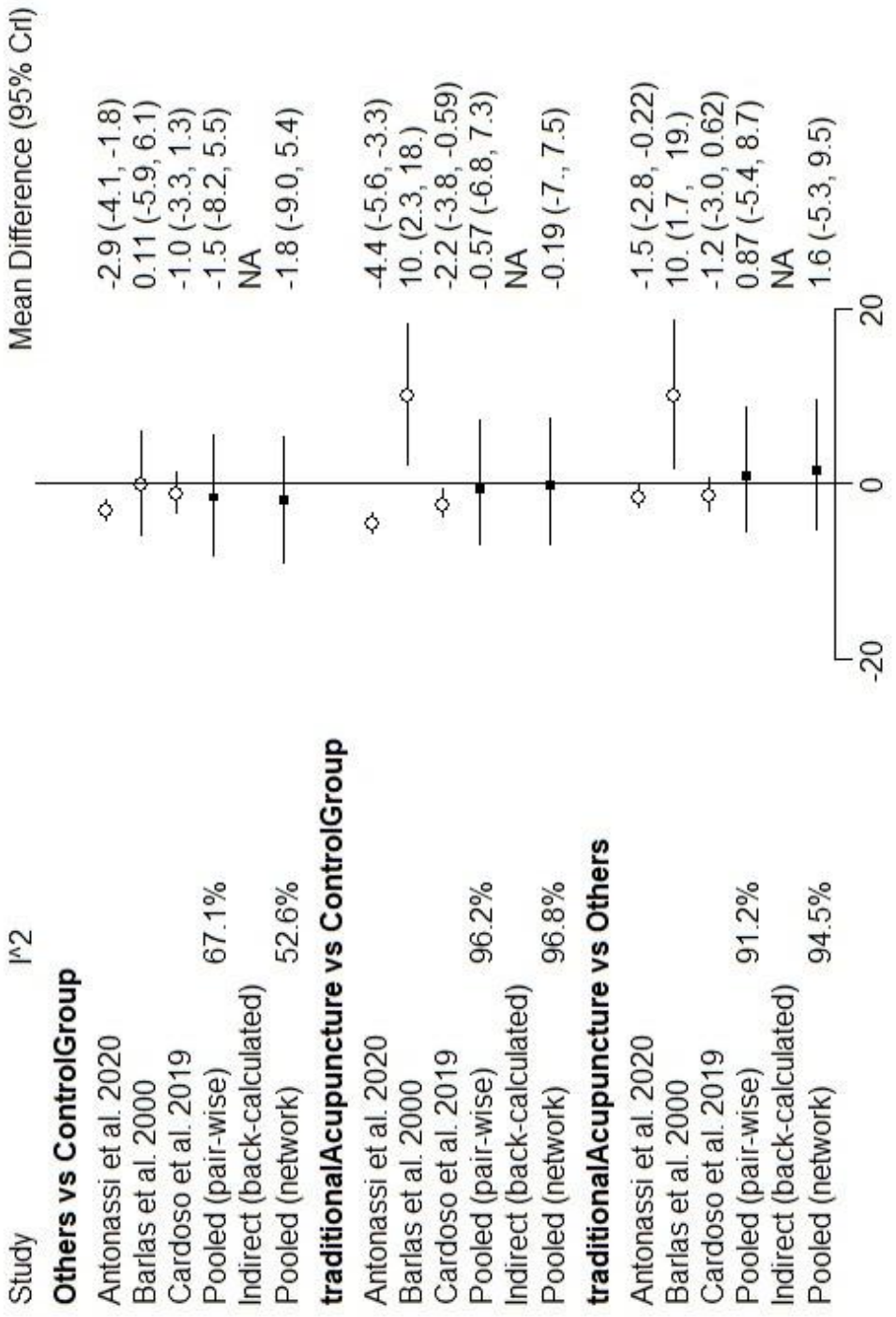


Figure 8. VAS 48 hours after treatment

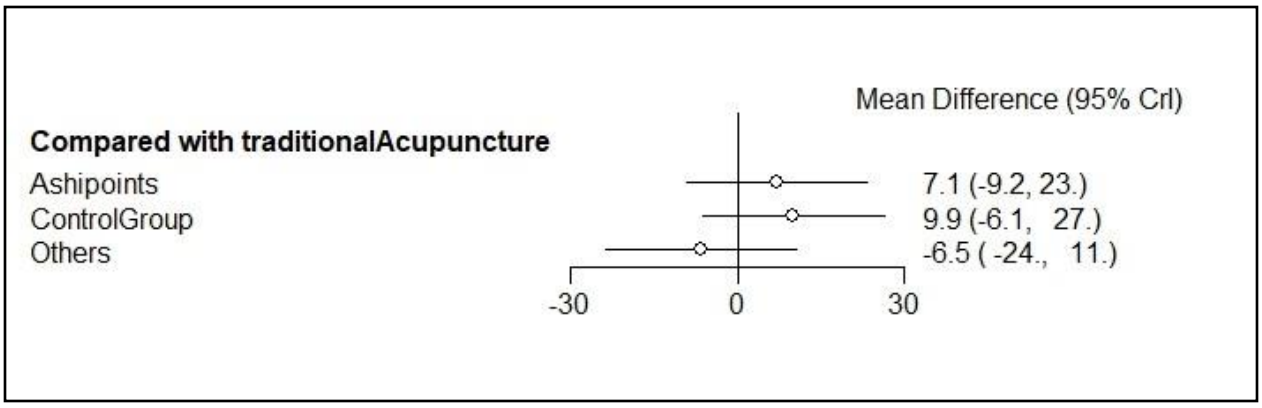


Figure 9. PPT after treatment

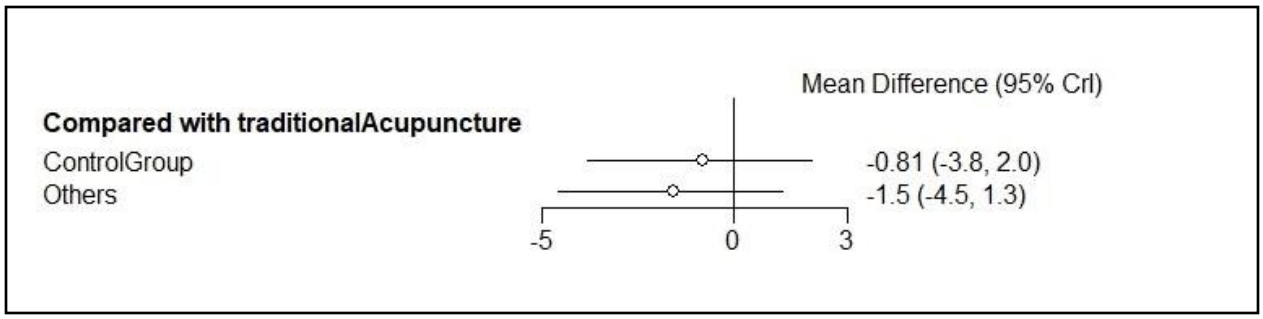
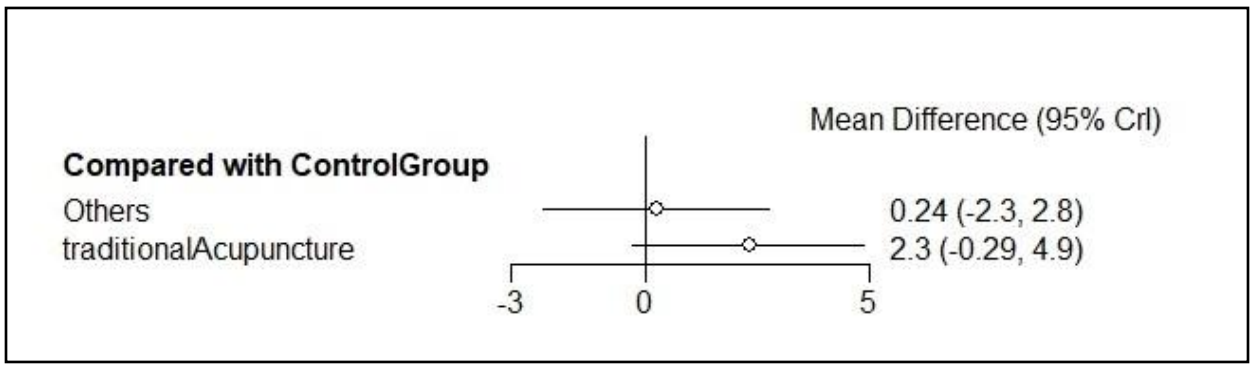


Figure 10. PPT 24 hours after treatment



CHAPTER II: EXTENDED LITERATURE REVIEW

Acupuncture benefits for musculoskeletal disorders are various (S. Li & Zhang, 2013; Lu, 2004; Tsuei, 1996), such as neck pain, frozen shoulder, sprained ankle, DOMS, etc. (Fu et al., 2021; Lee et al., 2023) . Existing studies showed that acupuncture can activate the sympathetic nervous system and increase the pain threshold (Itoh et al., 2011), when the pain threshold increases and people with disorders would feel less pain, this could be the main reason that acupuncture improves DOMS. However, as previously described, the factors of DOMS are many, and the main factors of DOMS are still not clear, acupuncture could not specifically work well for the unknown condition (Kaptchuk, 2002), since acupoints selected based on the meridian theory. Moreover, most of the studies that examined acupuncture for DOMS did not have significant differences from other needle treatments and control groups (Barlas et al., 2000; Chang et al., 2020; Fleckenstein et al., 2016; Huang et al., 2020; Nihonmatsu et al., 2011).

The effectiveness of acupuncture and DOMS has been polarization discussions, some studies showed a significant difference (Antonino et al., 2020; Cardoso et al., 2020; Itoh et al., 2008; Kim et al., 2014; Lin et al., 2009; Silvério-Lopes & Mota, 2018), but others showed there were no significant differences for acupuncture and DOMS (Antonassi et al., 2021; Barlas et al., 2000; Fleckenstein et al., 2016; Nihonmatsu et al., 2011), also they claimed that acupuncture did not have significant difference than other needle treatments for DOMS. Cardoso et al. (2020) indicated that acupuncture can significantly improve the pain pressure threshold (PPT) of DOMS, this finding was similar to previous studies (Fleckenstein et al., 2016; Itoh et al., 2011; W. Li et al., 2008; Silvério-Lopes & Mota, 2018; Targino et al., 2008; Xue et al., 2004; Zaslawski et al., 2003), this meaning after acupuncture, people with DOMS recover faster than people

who did not receive acupuncture treatment. Acupuncture could increase PPT, maybe due to its function of pain relief. Previous studies indicated that the function of acupuncture in analgesia and anesthetic effects is based on various endorphins released (Han et al., 1980; Han & Terenius, 1982; Ji-Sheng, 1985; Ji-Sheng Han & Guo-Xi Xie, 1984; Pomeranz, 1996; S.S. Cheng & Pomeranz, 1981; Ulett et al., 1998), and recent studies extended and comprehended the theories (Sims, 1997; Lee et al., 2004; Tsuei, 1996; Wong, 2016). Since that, there is no doubt that acupuncture can stop and relief pain, this can assume people who received acupuncture treatment would feel less pain than others, for this reason, they can move normally even they still have some DOMS symptoms.

On the other hand, based on the analgesia theory of acupuncture means, acupuncture can stop the pain and anesthesia the signal of the brain for the short or long term. However, the factors for DOMS are various. Gulick and Kimura (1996) provided six theories of DOMS: lactic acid, muscle cramps, torn tissue, connect-tissue, enzyme efflux, and tissue fluid theories, which were the base and early theories for DOMS. Until now, the factors for DOMS are still not clear. However, the lactic acid theory has been dismissed because the increased metabolic rate related to concentric muscle contractions, hasn't led to a comparable experience of delayed onset muscle soreness (Cheung et al., 2003; Hoppeler, 2014). The recent theories included mechanical, inflammation, and neurotrophic factors (Hotfiel et al., 2018). Many articles indicated that eccentric exercise-induced myofibril alterations mean after eccentric exercise-induced that tinny muscle will re-build up to enhance (Beaton et al., 2002; Fridén et al., 1983; Ulbricht et al., 2015; J.-G. Yu et al., 2003). In other words, muscle fiber broken is one of the factors for DOMS. Unfortunately, the existing data support that acupuncture can release and

stop pain, but lack of evidence that acupuncture improves the repair of muscle problems, one of the DOMS factors is tinny muscle fiber broken. Ma, Yun-Tao (2007) suggested that when a needle is inserted into the soft tissue, it triggers central and peripheral neuroimmunoendocrine and muscular physiological responses that restore balance, facilitating the body's natural healing process. Moreover, acupuncture can interact with and alter fascia. Inserting a needle into the fascia can impact tissues far from the insertion point. Addressing myofascial issues through this method seems to influence and correct posture (Mvb, 2012; Varhus & Huisheng Xie, 2019). If so, acupuncture can improve musculoskeletal disorders but no or less effectiveness for DOMS seems reasonable.

In addition, traditional acupuncture and Ashi-points comparison for DOMS lacks the data to reduce the bias. Existing data showed that traditional acupuncture did not have a significant difference from Ashi points for DOMS (Barlas et al., 2000; Fleckenstein et al., 2016; Hübscher et al., 2008). According to previous studies with fibromyalgia to compare traditional acupuncture and Ashi points, the results demonstrated there was no significant difference between traditional acupuncture and Ashi points (Assefi et al., 2005; Deluze et al., 1992; Harris et al., 2005). This may be due to the same effect of needle treatment (Choi et al., 2012). As mentioned before, needle treatment can adjust muscle posture and lead to self-healing, but those studies did not distinguish between traditional acupuncture and Ashi points. Traditional acupuncture treatment must follow meridian theories and specific point selection (Kaptchuk, 2002), without these, it is not traditional acupuncture.

Overall, the existing meta-analysis showed that acupuncture (including traditional acupuncture and ashi points) compared with placebo, and control groups for DOMS

the effectiveness still not clear (Chang et al., 2020; Ko & Clarkson, 2020), due to a lack of standardized points selection formula, induce exercise, and target papulation. Huang et al. (2020) showed that acupuncture had a long-lasting effect on DOMS until 72 hours compared with other interventions and examined with serum. Most studies conclude that acupuncture is effective for DOMS because of the pain relief function, this can be observed in the results based on PPT and mechanical pain threshold (MPT) (this is not included in this meta-analysis) (Ikeuchi et al., 2006; Itoh et al., 2008; Silvério-Lopes & Mota, 2018). The symptoms of DOMS influence athletes' performance more than the daily life of general people, further studies can improve the standard points selection formula for each muscle group and the target population can be specific for athletes.

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