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Systematic Review of the Effects of Acupuncture on BMI, Triglycerides, TNF-α, and IL-6 in Obesity Management

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ABSTRACT

Introduction: Obesity is a condition of excessive fat accumulation that has the potential to cause health problems. One of the safe and efficient adjuvant therapy for obesity is acupuncture with several techniques, such as manual acupuncture, laser acupuncture, electroacupuncture, and catgut implantation. The purpose of this systematic review is to determine the effect of acupuncture on body mass index (BMI), triglycerides (TG), tumor necrosis factor alpha (TNF-α), and interleukin 6 (IL-6) in obesity management.

Methods: This study was a systematic review with searches on PubMed and Scopus electronic database. Inclusion criteria were obese patients aged ≥18 years who received acupuncture treatment and reported improvements in BMI, TG, TNF-α, and IL-6; publication year 2014-2024; English language; randomized controlled trial (RCT) phase >3; and free full text.

Results: A total of 8 articles and 767 respondents were involved in this systematic review. Acupuncture was shown to significantly reduce BMI, TG, TNF-α, and IL-6 in obese patients.

Conclusion: Acupuncture was shown to significantly reduce BMI, TG, TNF-α, and IL-6 in obese patients.

INTRODUCTION

Obesity is a condition of excessive fat accumulation that can potentially cause health problems. A person is categorized as obese if their body mass index (BMI) is ≥ 30 kg/m2 (World Health Organization, 2021).

According to the World Health Organization (WHO), in 2016 there were >650 million adults worldwide who were obese. This figure has tripled compared to 1975. The Basic Health Research (RISKESDAS) states that the prevalence of obesity in Indonesia among people aged >18 years has increased from 15.4% (2013) to 21.8% (2018). In addition, the prevalence of central obesity in Indonesia among people aged >15 years also increased from 26.6% (2013) to 31% (2018) (Ministry of Health of the Republic of Indonesia, 2020).

Obesity is closely related to an increase in BMI. As a person's BMI increases, so does the risk of developing several diseases, such as breast cancer, diabetes mellitus, and hypertension (Masi & Oroh, 2018; Natalia et al., 2015; Neuhouser et al., 2015). In addition, obesity is also correlated with an increase in triglyceride (TG) levels due to fatty acid regulation disorders. Increased TG levels can cause atherosclerosis, which manifests in an increased risk of cardiovascular disease (Hastuty, 2015).

Obesity is classified as low-grade systemic inflammation. This is indicated by significantly higher mean concentrations of inflammatory biomarkers in the obese group compared to the control group (Arismendi et al., 2014). Excess adipose cells in obesity become sites of immune cell infiltration, which produce pro-inflammatory cytokines such as tumor necrosis factor alpha (TNF-α) and interleukin 6 (IL-6). Increased TNF-α and IL-6 are associated with an increased risk of chronic inflammation and increased insulin resistance, which in turn increases the risk of type 2 diabetes mellitus (Peña et al., 2023). Psychologically, obesity can cause low self-esteem, depression, and withdrawal from the environment due to being ridiculed by those around them (Fernando, 2019).
Obesity management can be done through diet therapy, pharmacotherapy, and bariatric surgery. There are various types of diet therapies, each with its limitations. Low-carbohydrate diet therapy causes the loss of glycogen and water stores and can slow down weight loss after 14 days of following the diet. In addition, calorie-restricted diet therapy has the potential to cause weight regain due to metabolic adaptation and loss of diet compliance (Ruban et al., 2019).

Pharmacotherapeutic agents that can be used for obesity management are limited and have undesirable side effects. Orlistat, as one option, causes loose and oily stools (Holmbäck et al., 2020). Liraglutide, as another option, has been reported to cause nausea, nasopharyngitis, diarrhea, and headaches (Garvey et al., 2020). Meanwhile, bariatric surgery has the potential to cause complications, such as Dumping Syndrome, which is a collection of symptoms caused by the rapid emptying of food in the small intestine (D'hoedt & Vanuytsel, 2023; Kalarchian et al., 2014).

Acupuncture is a safe and effective adjuvant therapy for obesity. Laser acupuncture performed on the CV 12 (zhongwan), ST 36 (zusanli), SP 6 (sanyinjiao), ST 25 (tianshu), and ST 40 (fenglong) points has been shown to reduce waist-to-hip ratio, total cholesterol, and low-density lipoprotein (LDL)

through increased lipolytic activity and lipid metabolism. In addition, acupuncture at these points also produced significant differences in BMI and appetite scores in the two groups after intervention (Sebayang et al., 2020). One study reported that acupuncture at 10 points, including CV 12 (zhongwan), ST 25 (tianshu), ST 36 (zusanli), SP 6 (sanyinjiao), CV 9 (shuifen), LI 4 (hegu), SP 15 (daheng), ST 28 (shuidao), LI 11 (quchi), and CV 6 (qihai) was shown to reduce TNF-α and IL-6 levels (Firouzjaei et al., 2016).

Based on the description in the paragraph above, obesity has the potential to increase the likelihood of developing several diseases, such as breast cancer, diabetes mellitus, and hypertension. Obesity therapies currently used by patients, such as diet therapy, pharmacotherapy, and bariatric surgery, have many undesirable side effects, so a safe and efficient adjuvant therapy, namely acupuncture, is needed. Therefore, the author considers it important to conduct a systematic review to determine the effect of acupuncture therapy on obesity.

METHODOLOGY

Research Design

This study used a systematic review design. A systematic review is a method for collecting and processing secondary data from all evidence relevant to predetermined inclusion and exclusion criteria (Philips & Barker, 2021).

Article Criteria

This systematic review was conducted based on The Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) 2020 (Page et al., 2021). Articles were searched for in published studies in the PubMed and Scopus electronic databases from 2014 to 2024; written in English; original research articles (phase 3 randomized controlled trials/RCTs) in peer-reviewed journals; written in the IMRaD structure (introduction, method, results, and discussion); and with the following PICO criteria.

Table 1. PICO Criteria

Criteria	Description
Research subject	Obese patients
(Population = P)	Acupuncture therapy
Intervention	Other therapies
(Intervention = I)	Improvement in BMI, TG, TNF-α, and IL-6

In addition, the articles used in this systematic review are also studies that meet the following inclusion and exclusion criteria.

Table 2. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusions
Study population	Obese patients aged ≥18 years	Animal study population
Intervention/treatment in the study	Acupuncture	Trial
Control group	Other therapies	Patients with obesity aged <18 years
Research results	Improvement in BMI, TG, TNF-α, and IL-6	Other therapies
Electronic database	PubMed and Scopus	Acupuncture
Year of publication	2014-2024	Improvements other than BMI, TG, TNF-α, and IL-6
Language used	English	Other than PubMed and Scopus
Study design	Randomized controlled trial (RCT)	Before 2014
Access to articles	Full access in the form of full text (free full text)	Other than English

Article Search Strategy

The article search strategy uses Medical Subject Heading (MeSH) terms combined with Boolean operators and filters from each electronic database, as shown in the following table.

Table 3. Queries in Article Searches in Electronic Databases

Electronic databases	**MeSH t*erms* atau *keywords***	**Filter**
PubMed	*(obesity [MeSH Terms]) AND (acupuncture [MeSH Terms])*	*Publication date: 10 years;* *Article type: Randomized Controlled Trial;* *Text availability: Free full text*
Scopus	*(obesity AND acupuncture AND "randomized controlled trial")*	*Publication year: 2014-2024;* *Document type: Article; Language: English;* *Open access: Gold*

Article Recording Strategy

First, collect articles by identifying them based on MeSH terms filters and keyword combinations in the Pubmed and Scopus electronic databases, then record the number. Next, check for duplication between databases. If there is

duplication, record and report the number. Next, sort the articles according to the suitability of the title and abstract to be recorded and reported. The sorted articles are then downloaded in full text.

The articles that were successfully downloaded were recorded and reported in terms of number, and then assessed for suitability based on the inclusion and exclusion criteria that had been set at the beginning. The number of articles that were suitable and excluded was recorded and reported. The number of articles that were excluded was reported according to the exclusion criteria that caused the articles to be removed from the selection.

Additional articles that were the result of hand searching or backward citation from the bibliography of the selected articles above underwent the same selection steps. The selected additional articles were then added to the articles that had been selected at the beginning, and then the total number was recorded and reported.

The selected articles were then manually extracted. The data were summarized in a table using Microsoft Excel, which presented the general characteristics of the studies, including the name of the researcher, year of study, name of study (country), study design, acupuncture technique, control, number of samples, duration of treatment, and inclusion criteria.

Data Synthesis

Synthesis of results is the presentation of a series of evidence from articles that have been sorted based on inclusion and exclusion criteria to answer systematic review questions. The presentation of results in this systematic review is in the form of narratives, tables, diagrams, and images that describe all the evidence obtained. The results of data processing are combined and then evaluated to obtain the overall conclusions of the articles used in this systematic review.

RESEARCH RESULT

Research Selection

The selection of articles in this systematic review followed the PRISMA 2020 flow chart as described in Figure 1.

The search for articles in PubMed using the specified query was followed by activating the following PubMed filter functions: Free full text, Randomized Controlled Trial, and publication date 10 years. The final results of the PubMed search yielded 24 articles. The article search in Scopus used the specified keywords and was refined with the filter functions years = 2014-2024, document type = articles, language = English, and open access = gold. The final results of the Scopus search yielded 44 articles.

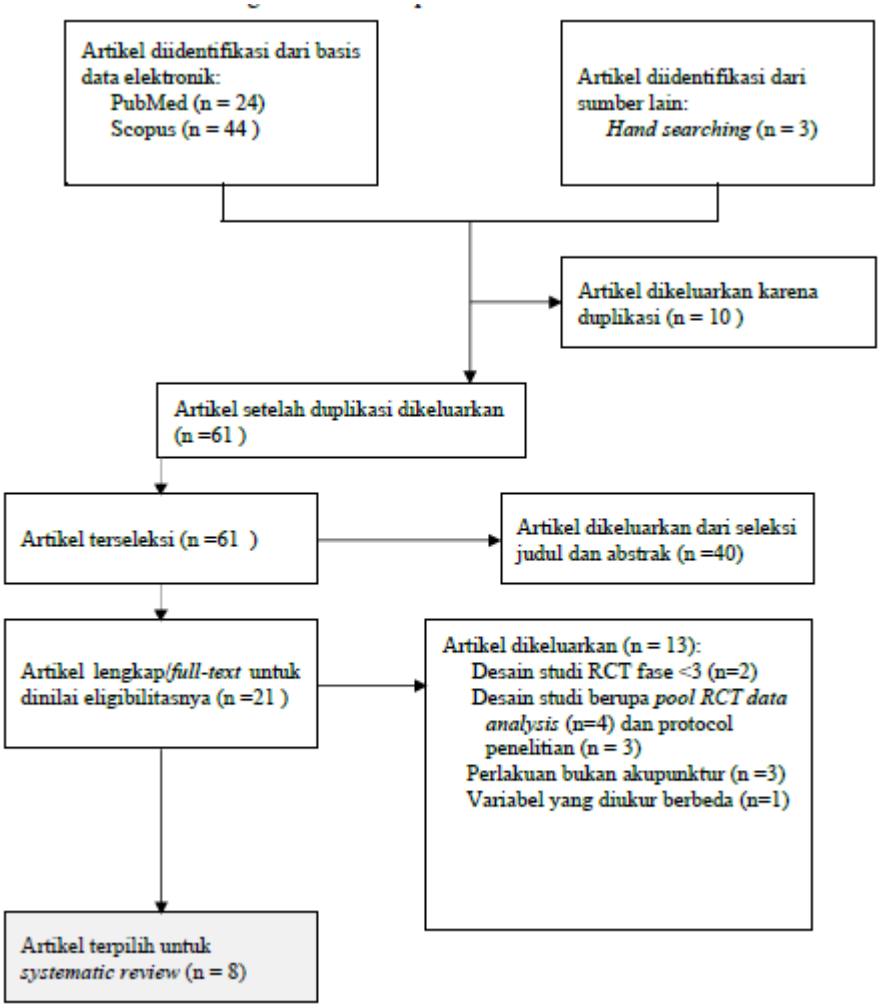

Figure 1. Article Selection Process Flowchart

The search from other sources was conducted manually (hand searching) by searching for references in articles that had been selected from the PubMed and Scopus electronic databases. Using the same method as that used for electronic databases, articles were searched for by hand, and three articles were found.

The total number of articles obtained from the above search process was 71 articles. Then, a check was carried out using Mendeley Reference Manager and 10 duplicate articles were found. After removing the duplicates, 61 articles were obtained, which were then screened based on their titles and abstracts. At this stage, 40 articles were removed, resulting in 21 articles that were then downloaded in full text for reading. At this stage, eligibility was assessed based on inclusion and exclusion criteria. After the eligibility assessment, 13 articles were excluded because they did not meet the specified inclusion criteria, with 2 articles excluded because the study design was a phase one or two RCT, 4 articles excluded because the study design was a reanalysis of RCT databases, and 3 articles were research protocols. 3 articles were excluded because the research intervention was not acupuncture, and 1 article was excluded because the research outcome was not a change in BMI, TG levels, TNF-α levels, and IL-6 levels. Thus, from the selection process, 8 research articles were obtained, which

were then assessed for study quality using the Jadad scale or the Oxford Quality Scoring System.

Research Bias Risk

The assessment of bias risk using the Jadad scale on the 8 research articles reviewed showed that all articles reviewed were of good quality (Jadad scale ≥ 3). The assessment using the Jadad scale was carried out by 2 reviewers independently to avoid assessment bias (Berger & Alperson, 2009). Of the 8 studies reviewed, all received the highest Jadad score of 5, indicating that the studies reviewed were of very good quality.

The results of the quality assessment using the Jadad scale for the 8 research articles reviewed included 7 items, namely random sequence generation, allocation concealment, blinding of participants and personnel (blinding of research samples and researchers), blinding of outcome assessment (blinding of research outcome assessment), incomplete outcome data (data loss to follow-up), selective outcome reporting (selective reporting of research results), and other biases (other sources of bias), all of which showed low risk of bias as shown in Table 4.

Table 4. Risk of Bias Assessment Using the Jadad Scale

No	Study	D1	D2	D3	D4	D5	D6	D7	*Overall*
1.	Hung *et al*., 2016	+	+	+					3
2.	Xinghe *et al*., 2023	+	+	+	+	+			5
3.	He *et al*., 2015	+	+	+					3
4.	Lam *et al*., 2024	+	+	+	+	+			5
5.	Chen *et al*., 2020	+	+	+					3
6.	Firouzjaei *et al*., 2016	+	+	+					3
7.	Razzaghi *et al*., 2023	+	+	+	+	+			5
8.	Ismail, 2023	+	+	+					3

Description:

D1 = *random sequence generation* (*selection bias*)

D2 = *allocation concealment* (*selection bias*)

D3 = *blinding of participant and personnel* (*performance bias*)

D4 = *blinding of outcome assessment* (*detection bias*)

D5 = *incomplete outcome data*

D6 = *selective outcome reporting* (*reporting bias*)

D7 = *double blinding but it's not true*

Research Results Each Study

The findings from each study reviewed in this systematic review are presented in Table 5.

Table 5. Research Results for Each Study

No	Study	Treatment/	Control group	Research results in the treatment group (before and after intervention)	Research results in the control group (before and after intervention)
1.	Hung *et al*., 2016	intervention	Sham acupuncture	BMI differed significantly ($p < 0.001$)	BMI did not differ
2.	Xinghe *et al*., 2023	In this study, 66 people were randomly divided into 2 groups. Treatment with laser acupuncture at points ST 25 (tianshu), ST 28 (shuidao), ST 40 (fenglong), SP 15 (daheng), CV 9 (shuifen), and SP 6 (sanyinjiao) for 5 sessions per week, totaling 12 sessions. Treatment lasted approximately 3 weeks.	Thread implantation not at acupuncture points	BMI differed significantly ($p < 0.001$) both after 6 sessions and after a 4-week follow-up	BMI differed significantly ($p < 0.001$) after 6 sessions but there was no difference after a 4-week follow-up
3.	He *et al*., 2015	In this study, 92 people were randomly divided into two groups. Treatment with thread implantation at points BL 20 (pishu), BL 21 (weishu), BL 25 (dachangshu), CV 12 (zhongwan), and ST 25 (tianshu) every 2 weeks, for a total of 6 sessions,	Manual acupuncture and massage therapy	BMI decreased but not significantly	BMI decreased but not significantly

		followed by a 4-week follow-up.			
4.	Lam *et al*., 2024	In this study, 56 people were randomly divided into two groups. Treatment with manual acupuncture at points ST 25 (tianshu), ST 21 (liangmen), SP 15 (daheng), ST 36 (zusanli), SP 6 (fenglong), LI 11 (quchi), SJ 6 (zhigou), RN 12 (zhongwan), and RN 06 (qihai) daily for 3 weeks.	Sham acupuncture	BMI decreased significantly both during treatment and 8 weeks after treatment	BMI decreased significantly during treatment but not during follow-up
5.	Firouzjaei *et al*., 2016	In this study, there were 168 respondents who were divided into 2 groups at random. EA treatment was applied to points ST 25 (tianshu), SP 15 (daheng), GB 26 (daimai), CV 6 (qihai), CV 12 (zhongwan), ST 36 (zusanli), ST 40 (fenglong), and SP 6 (sanyinjiao) for 8 weeks followed by an 8-week follow-up.	Metformin	Significant differences in BMI, TNF-α, IL-6, and TG ($p < 0.001$)	Non-significant differences in BMI, TNF-α, IL-6, and TG ($p > 0.05$)
6.	Razzaghi *et al*., 2023	In this study, there were 39 respondents who were divided into	Sham acupuncture	Significant differences in BMI and TG ($p < 0.001$)	No significant difference in

		two groups randomly. In the treatment group, there were 19 respondents and in the control group there were 20 respondents.			IMT and TG ($p > 0.05$)
7.	Ismail, 2023	In this study, the treatment group received EA therapy for 3 weeks with 10 treatments at the following points: REN 12 (zhongwan), ST 25 (tianshu), ST 36 (zusanli), SP 6 (sanyinjiao), REN 9 (shuifen), LI 4 (hegu), SP 15 (daheng), ST 28 (shuidao), REN 4 (guanyuan), LI 11 (quchi), and REN 6 (qihai).	Sham acupuncture	Significant differences in BMI and TG ($p < 0.001$)	No significant difference in IMT and TG ($p > 0.05$)
8.	Chen *et al*., 2020	In this study, there were 60 respondents divided into 2 groups randomly. In the treatment group, patients received laser acupuncture 3 times a week for 1 month (12 treatments) at the points GV 20 (baihui), HT 7 (shenmen), PC 6 (neiguan), LI 4	Sham acupuncture	Significant differences in BMI ($p < 0.001$)	No significant difference in IMT and TG ($p > 0.05$)

		(hegu), ST 36 (zusanli), LR 3 (taichong), and LR 13 (zhangmen).			

Research Synthesis Results

Obesity is a condition of excessive fat accumulation that has the potential to cause health problems. A person is categorized as obese if their body mass index (BMI) is ≥ 30 kg/m2 (World Health Organization, 2021).

Acupuncture is a treatment method that stimulates acupuncture points to influence the flow of bioenergy in the body based on the philosophy of balance and the relationship between the body surface and internal organs through a specific meridian system.

This systematic review discusses 8 studies that meet the predetermined inclusion and exclusion criteria. Based on the 8 journals reviewed, all journals contained studies on the effect of acupuncture on BMI in obese patients, where 7 of them provided significant results between the control group and the treatment group, while the other 1 provided insignificant results between the control group and the treatment group.

Based on the 8 studies reviewed in this systematic review, there were 3 studies that examined the effect of acupuncture on TG levels in obese patients. The results showed a significant difference in the effect of acupuncture on TG levels between the treatment group and the control group in obese patients.

Based on the eight studies reviewed in this systematic review, there was one study that examined the effect of acupuncture on TNF-α and IL-6 levels in obese patients. The results showed a significant difference in the effect of acupuncture on TNF-α and IL-6 levels in obese patients between the treatment group and the control group.

DISCUSSION

The Effect of Acupuncture on BMI in Obesity Management

This systematic review examined eight studies. Of the eight studies reviewed, seven showed a significant difference in BMI between the treatment group and the control group, while one study showed a difference in BMI between the treatment group and the control group but it was not significant.

The seven studies that showed a significant difference in the effect of acupuncture on obesity on BMI were conducted by Hung et al. (2016), Xinghe et al. (2023), Lam et al. (2024), Firouzjaei et al. (2016), Razzaghi et al. (2023), Ismail (2023), and Chen et al. (2020). The acupuncture methods used in these eight studies were EA in three studies, thread implantation in two studies, laser acupuncture in two studies, and manual acupuncture in one study.

Based on the study by Hung et al. (2016), a significant relationship was found between the effects of acupuncture and BMI. The decrease in BMI was 6.34 (SD: 2.34) after six treatments and 7.46 (SD: 2.40) at the three-month evaluation in the laser acupuncture group, while in the sham control group, it was 0.72 (SD:

3.40) after six treatments and 1.39 (SD: 3.40) at the three-month evaluation with a p-value < 0.001.

Based on the study by Xinghe et al. (2023), there was a significant relationship between BMI and acupuncture with a p-value of <0.001. The initial BMI data in the treatment group was 27.93 (SD: 3.31) and in the control group was 28.01 (SD: 3.75). There was a significant difference between the treatment group and the control group both at 0–12 weeks (p<0.001) and after follow-up (p < 0.001), but the journal article did not mention the decrease.

The results of the study by Lam et al. (2024) showed a significant change in BMI in the treatment group from an initial value of 29.9 (SD: 4.2) to a change of -0.4 (95% CI -0.6 to -0.2) at week 4 of therapy, there was a change of -0.4 (95% CI -0.6 to -0.1), at week 16 of therapy, and a change of -0.9 (95% CI -0.3 to -0.1). Meanwhile, in the control group, there was no significant change from the initial condition of 29.5 (SD: 3.9) with a change of -0.2 (95% CI -0.8 to -0.2), at week 4 of therapy, there was a change of -0.4 (95% CI -0.9 to -0.3), at week 16 of therapy, the change was -0.9 (95% CI -1.0 to -0.3).

Chen et al. (2020) mentioned in their research results that there was a significant difference in the treatment group, but the results were not mentioned. The results of the study by Firouzjaei et al. (2016) reported BMI measurements before therapy of 27.6 ± 2.5 to 26.2 ± 2.4 after therapy and a significant difference (p < 0.001) in the treatment group.

Razzaghi et al. (2023) in their study mentioned that there was a difference in BMI in the treatment group between before and after treatment, with a statistically significant change of 1.09 ± 0.88 (p = 0.0001).

The results of Ismail's (2023) study indicate a statistically significant difference between the BMI of the treatment group, where the BMI before treatment was 33.82 ± 2.51 and the BMI after treatment was 32.75 ± 2.49 (p < 0.001). Meanwhile, in the control group, the BMI before treatment was 33.78 ± 3.32 and the BMI after treatment was 33.75 ± 3.29 (p = 0.580). This shows that the treatment in the control group, which was sham acupuncture, did not show significant results in terms of changes in BMI.

He et al. (2015) reported a decrease in BMI in both the treatment and control groups, but the difference was not statistically significant. In the treatment group, BMI before therapy was 27.64 ± 0.29 and after treatment was 26.44 ± 0.29 (p < 0.001). In the control group, BMI before treatment was 25.57 ± 0.21 and after treatment was 24.88 ± 0.21 (p < 0.001). When comparing the treatment group and the control group, there was no statistically significant difference (p = 0.363). In this study, the treatment group underwent manual acupuncture, while the control group underwent manual acupuncture and massage. Based on the efficacy of acupuncture, the mechanism of massage in treating obesity may involve adipose degradation or catabolism, increased intestinal peristalsis, and reduced parasympathetic nerve stimulation.

Therefore, it can be concluded that acupuncture has an effect on BMI in the management of obesity. Various acupuncture methods, such as laser acupuncture, catgut implantation, EA, and manual acupuncture, have been shown to significantly reduce BMI in the treatment group after intervention.

The Effect of Acupuncture on TG in Obesity Management

The results of a study by Firouzjaei et al. (2016) stated that there was a significant change in TG levels in the treatment group from 2.59 ± 0.6 mmol l-1 to 2.24 ± 0.6 mmol l-1 ($p<0.001$). Meanwhile, in the control group, TG levels before treatment were 2.24 ± 0.5 mmol l-1 and became 4.0 ± 0.5 mmol l-1 after treatment ($p = 0.324$), which means that the change was not significant.

Razzaghi et al. (2023) reported TG results in the treatment group with a difference before and after treatment of 12.67 ± 17.34 mg/dL (p 0.0001) and the control group 10.23 ± 15.98 mg/dL ($p = 0.010$).

Ismail's (2023) study found TG levels in group A (treatment group) before treatment to be 176.53 ± 87.70 mg/dL and after treatment to be 139.53 ± 58.38 mg/dL ($p <0.001$). Meanwhile, in group B (control group), the TG level before treatment was 179.86 ± 88.63 mg/dL and after treatment was 178.49 ± 87.11 ($p = 0.215$).

Therefore, it can be concluded that acupuncture has an effect on TG in the management of obesity. Acupuncture has been proven to significantly reduce TG in the treatment group after intervention.

The Effect of Acupuncture on TNF-α in the Management of Obesity

The results of the study by Firouzjaei et al. (2016) found a significant change in TNF-α levels in the treatment group from 1.44 ± 0.2 pg m/L before therapy to 1.41 ± 0.5 pg m/L after therapy ($p = 0.001$). Additionally, there was a significant difference in the decrease in TNF-α levels between the treatment group and the control group ($p = 0.04$).

The Effect of Acupuncture on IL-6 in the Management of Obesity

The results of the study by Firouzjaei et al. (2016) found a significant change in IL-6 levels in the treatment group from 1.44 ± 0.3 pg m/L to 1.09 ± 0.5 pg m/L ($p < 0.001$). In addition, there was a significant difference in the decrease in IL-6 levels between the treatment group and the control group ($p = 0.001$).

The Mechanism of Acupuncture on BMI in Obesity Management

According to Hung et al. (2016), acupuncture can reduce BMI through the mechanism of regulating obesity-related neuropeptides in the central nervous system. In addition, this study also included a placebo control group and added the SP 6 point, which affects water metabolism. Besides stimulating other acupuncture points on the body, stimulating the hunger and stomach points on the ear is also known to play a role in weight loss by suppressing ghrelin production.

Razzaghi et al. (2023) found in their study that stimulating acupuncture points related to obesity and appetite affects the levels of neuropeptides that influence appetite, such as ghrelin and serotonin. Treatment with laser acupuncture resulted in a significant reduction in appetite.

Lam et al. (2024) in their study used the ST 40 and SP 6 points located on the lower leg. The acupuncture points selected on the lower leg are considered

effective in stabilizing digestive function and improving fluid drainage. An increase in satiety was reported by several subjects in the treatment group. In addition to the points on the legs, Lam et al. (2024) also used points in the abdominal area, including ST 25, SP 15, GB 26, CV 6, and CV 12. Among the acupuncture points used, the classical function of the abdominal points is to harmonize digestive function and treat local problems that are a response to excessive adipose tissue accumulation in the abdomen.

Chen et al. (2020) also found significantly different results in BMI reduction between the treatment group and the control group in their study. The treatment group in this study was given an intervention in the form of catgut thread implantation at acupuncture points, while the control group was given an intervention in the form of catgut thread implantation at sham acupuncture points.

He et al. (2015) explained that the mechanism of acupuncture for treating obesity is through appetite suppression, regulation of obesity-related peptides (increased cocaine- and amphetamine-regulated gene expression, and decreased ghrelin and leptin), and fat metabolism (decreased total cholesterol, TG, low-density lipoprotein, lipoprotein A, and lipoprotein A), apolipoprotein B levels, increased insulin and C-peptide levels, and in cases of obesity, decreased glucose levels. In this study, massage was performed for the control group. Based on the efficacy of acupuncture, the mechanism of massage in treating obesity may involve adipose degradation or catabolism, increased intestinal peristalsis, and reduced parasympathetic nerve stimulation.

According to a study by Xinghe et al. (2023), there were significant differences in BMI reduction between the treatment group and the control group. According to Xinghe et al. (2023), this is because after acupuncture, there are different effects on Qi, mast cell degranulation, adenosine release, brain tissue regulation, and target organs.

In the study by Firouzjaei et al. (2016), there were significantly different results between the treatment group and the control group in terms of BMI reduction. It is estimated that acupuncture has an effect on weight loss through different mechanisms, such as reducing hunger, affecting lipid and carbohydrate metabolism, affecting glucose-inhibited neuron activity, modulating eating behavior, and reducing anti-inflammatory mechanisms.

Ismail (2023) also found significantly different results in BMI reduction between the treatment group and the control group in his study. The mechanism is through stimulation of the peripheral nerves around the stimulated acupuncture points, which carry electrical signals to modulate and/or control the mood and satiety of patients with obesity. In humans, EA can relax the sphincter of Oddi (SoD). SoD relaxation induced by EA can increase the sensation of fullness and therefore reduce the frequency of overeating.

Therefore, it can be concluded that acupuncture is significantly capable of reducing BMI through several mechanisms, primarily through the regulation of neuropeptides and metabolism associated with obesity. Acupuncture suppresses ghrelin production, thereby reducing appetite and increasing satiety.

Additionally, acupuncture is also capable of improving fat metabolism in the body.

The Mechanism of Acupuncture on TG, TNF-α, and IL-6 in the Management of Obesity

Razzaghi et al. (2023) stated that there was a decrease in lipid profile and plasma glucose levels in the laser acupuncture group and the control group, which was associated with weight loss in both groups. On the other hand, the effect of laser acupuncture on gene expression in adipose tissue was remarkable. Morphological changes, including a reduction in adipose cell size and subcutaneous fat, have been reported after laser acupuncture treatment. Overall, all mechanisms that affect insulin-like growth factor-1 (IGF-1) and different insulin resistance factors can cause changes in glucose and lipid metabolism, thereby reducing body fat percentage and promoting weight loss.

Meanwhile, according to Firouzjaei et al. (2016), the significant changes observed in the lipid profile between the case group and the control group confirm the potential systemic effects of EA in improving dyslipidemia, particularly by modulating free fatty acid levels, which in turn can influence insulin secretion and insulin resistance in type 2 diabetes mellitus. The results of this study suggest that EA restores the expression of different adipose tissue genes associated with insulin resistance, obesity, and inflammation. As a result, we conclude that EA can prevent resistance as a kind of insulin sensitizer while also improving lipid metabolism mechanisms. Additionally, EA may treat obesity by altering the lipid profile. EA may also overcome obesity through other mechanisms, such as suppressing inflammation and increasing lipid metabolism. Therefore, it can be concluded that acupuncture is significantly capable of reducing TG, TNF-α, and IL-6 through various mechanisms, including reducing adipose cell size and subcutaneous fat, as well as increasing lipid metabolism in the body.

CONCLUSION AND RECOMMENDATIONS

The systematic review successfully identified and mapped eight research articles that were carefully selected using the PRISMA 2020 protocol and concluded that acupuncture can reduce BMI, TG, TNF-α, and IL-6 in the management of obesity.

FURTHER RESEARCH

Acupuncture for obesity has an effect on TNF-α and IL-6. However, not many researchers have conducted this study, so it is highly recommended that researchers and practitioners provide acupuncture therapy for obese patients and measure TNF-α and IL-6 levels.

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REFERENCES

Arismendi, E., Rivas, E., Agustí, A., Ríos, J., Barreiro, E., Vidal, J., & Rodriguez-Roisin, R. (2014). The systemic inflammome of severe obesity before and after bariatric surgery. *PLoS ONE*, *9*(9). https://doi.org/10.1371/journal.pone.0107859

Berger, V. W., & Alperson, S. Y. (2009). A general framework for the evaluation of clinical trial quality. *Reviews on recent clinical trials*, *4*(2), 79-88.

Chen, X., Huang, W., Wei, D., Ding, D. G., Jiao, Y., Pan, H. L., Jin, Y. T., Zheng, Y. W., Zhang, Y. J., Zhang, Y. R., Liu, Y. R., & Zhou, Z. Y. (2020). Clinical effect of catgut implantation at acupoints for the treatment of simple obesity: A multicentre randomized controlled trial. *Medicine (United States)*, *99*(48), E23390. https://doi.org/10.1097/MD.0000000000023390

D'hoedt, A., & Vanuytsel, T. (2023). Dumping syndrome after bariatric surgery: prevalence, pathophysiology and role in weight reduction-a systematic review. *Acta Gastro-Enterologica Belgica*, *86*(3), 417-427.

Fernando, M. L. (2019). Gambaran citra tubuh pada wanita dewasa awal yang mengalami obesitas. *Jurnal Ilmiah Psikologi Terapan*, *7*(1), 101–118. https://doi.org/10.22219/jipt.v7i1.6369

Firouzjaei, A., Li, G. C., Wang, N., Liu, W. X., & Zhu, B. M. (2016). Comparative evaluation of the therapeutic effect of metformin monotherapy with metformin and acupuncture combined therapy on weight loss and insulin sensitivity in diabetic patients. *Nutrition and Diabetes*, *6*. https://doi.org/10.1038/nutd.2016.16

Garvey, W. T., Birkenfeld, A. L., Dicker, D., Mingrone, G., Pedersen, S. D., Satylganova, A., Skovgaard, D., Sugimoto, D., Jensen, C., & Mosenzon, O. (2020). Efficacy and safety of liraglutide 3.0 mg in individuals with overweight or obesity and type 2 diabetes treated with basal insulin: The SCALE insulin randomized controlled trial. *Diabetes Care*, *43*(5), 1085–1093. https://doi.org/10.2337/dc19-1745

Hastuty, Y. D. (2018). Perbedaan kadar kolesterol orang yang obesitas dengan orang yang non obesitas. *AVERROUS: Jurnal Kedokteran dan Kesehatan Malikussaleh*, *1*(2), 47-55.

He, J., Zhang, X., Qu, Y., Huang, H., Liu, X., Du, J., & Guo, S. (2015). Effect of Combined Manual Acupuncture and Massage on Body Weight and Body Mass Index Reduction in Obese and Overweight Women: A Randomized, Short-term Clinical Trial. *JAMS Journal of Acupuncture and Meridian Studies*, *8*(2), 61–65. https://doi.org/10.1016/j.jams.2014.08.001

Holmbäck, U., Forslund, A., Grudén, S., Alderborn, G., Söderhäll, A., Hellström, P. M., & Lennernäs, H. (2020). Effects of a novel combination of orlistat and acarbose on tolerability, appetite, and glucose metabolism in persons with obesity. *Obesity Science and Practice*, *6*(3), 313–323. https://doi.org/10.1002/osp4.405

Hung, Y. C., Hung, I. L., Hu, W. L., Tseng, Y. J., Kuo, C. E., Liao, Y. N., Wu, B. Y., Tsai, C. C., Tsai, P. Y., Chen, H. P., Huang, M. H., & Su, F. Y. (2016). Reduction in postpartum weight with laser acupuncture A randomized control trial. *Medicine (United States)*, *95*(34). https://doi.org/10.1097/MD.0000000000004716

Ismail, A. M. A. (2023). Lipid Profile Response to Acupuncture in Obese Patients with Subjective Tinnitus: a Randomized Controlled Trial. *JAMS Journal of Acupuncture and Meridian Studies*, *16*(1), 11–19. https://doi.org/10.51507/j.jams.2023.16.1.11

Kalarchian, M. A., Marcus, M. D., Courcoulas, A. P., Cheng, Y., & Levine, M. D. (2014). Self-report of gastrointestinal side effects after bariatric surgery. *Surgery for Obesity and Related Diseases*, *10*(6), 1202–1207. https://doi.org/10.1016/j.soard.2014.08.007

Kementerian Kesehatan Republik Indonesia. (2020). *Riset Kesehatan Dasar 2018*.

Lam, T. F., Lyu, Z., Wu, X., Wong, Y. P., Cao, P., Wong, E. Y., Hung, H. B., Zhang, S., Bian, Z., & Zhong, L. L. D. (2024). Electro-acupuncture for central obesity: a patient-assessor blinded, randomized sham-controlled clinical trial. *BMC Complementary Medicine and Therapies*, *24*(1). https://doi.org/10.1186/s12906-024-04340-5

Masi, G., & Oroh, W. (2018). Hubungan Obesitas dengan Kejadian Diabetes Melitus di Wilayah Kerja Puskesmas Ranomut Kota Manado. *Jurnal Keperawatan*, *6*.

Natalia, D., Hasibuan, P., & Hendro. (2015). Hubungan Obesitas dengan Kejadian Hipertensi di Kecamatan Sintang, Kalimantan Barat. *Cermin Dunia Kedokteran*, *42*.

Neuhouser, M. L., Aragaki, A. K., Prentice, R. L., Manson, J. A. E., Chlebowski, R., Carty, C. L., Ochs-Balcom, H. M., Thomson, C. A., Caan, B. J., Tinker, L. F., Urrutia, R. P., Knudtson, J., & Anderson, G. L. (2015). Overweight, obesity, and postmenopausal invasive breast cancer risk: A secondary analysis of the women's health initiative randomized clinical trials. *JAMA Oncology*, *1*(5), 611–621. https://doi.org/10.1001/jamaoncol.2015.1546

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder,

E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. I: *PLoS Medicine* (Bd. 18, Nummer 3). Public Library of Science. https://doi.org/10.1371/JOURNAL.PMED.1003583

Peña, A., Olson, M. L., Ayers, S. L., Sears, D. D., Vega-López, S., Colburn, A. T., & Shaibi, G. Q. (2023). Inflammatory Mediators and Type 2 Diabetes Risk Factors before and in Response to Lifestyle Intervention among Latino Adolescents with Obesity. *Nutrients*, *15*(11). https://doi.org/10.3390/nu15112442

Phillips, V., & Barker, E. (2021). Systematic reviews: Structure, form and content. *Journal of Perioperative Practice*, *31*(9), 349–353. https://doi.org/10.1177/1750458921994693

Razzaghi, M., Akbari, Z., Mokmeli, S., Razzaghi, Z., Rezaei-Tavirani, M., Afzalimehr, M., & Kamani, E. (2023). Laser Diode - GaAlAs Acupuncture in the Treatment of Central Obesity: a Randomized Clinical Trial. *JAMS Journal of Acupuncture and Meridian Studies*, *16*(6), 255–262. https://doi.org/10.51507/j.jams.2023.16.6.255

Ruban, A., Stoenchev, K., Ashrafian, H., & Teare, J. (2019). Current treatments for obesity. *Clinical Medicine*, *19*(3), 205–212. https://doi.org/10.7861/clinmedicine.19-3-205

Sebayang, R. G., Aditya, C., Abdurrohim, K., Lauwrence, B., Mihardja, H., Kresnawan, T., & Helianthi, D. R. (2020). Effects of Laser Acupuncture and Dietary Intervention on Key Obesity Parameters. *Medical Acupuncture*, *32*(2), 108–115. https://doi.org/10.1089/acu.2019.1398

World Health Organization. (2021). *Obesity and Overweight*. World Health Organization.

Zhang, X., Li, Q., Yi, R., Xing, C., Jin, Y., Meng, J., Feng, J., Zhao, S., Liang, F., & Guo, T. (2023). Effect of catgut embedding at acupoints versus non-acupoints in abdominal obesity: a randomized clinical trial. *Journal of Traditional Chinese Medicine*, *43*(4), 781–786. https://doi.org/10.19852/j.cnki.jtcm.20230608.002