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Review Article

# Electroacupuncture Treatment for Women with Primary Obesity: A Review of Randomized Controlled Trials

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**ABSTRACT**

The purpose of this review was to evaluate the effectiveness of electroacupuncture treatment for women with "primary obesity." Primary obesity is caused by an imbalance in energy intake and consumption due to abnormal eating and living habits in the absence of specific diseases causing the obesity. A literature review (up to December 2019) of randomized controlled trials (RCT) of electroacupuncture treatment for women with "primary obesity" was performed. Relevant clinical studies were retrieved from several databases, and interventions and results were analyzed. There were 6 RCT that fitted the inclusion criteria for this review. The intervention for the treatment group of the selected 6 RCT was electrical stimulation applied to acupoints. Interventions for the control groups included non-treatment, general acupuncture, and so on. Indicators for assessing treatment effects varied from study to study. Four out of 5 studies used body mass index (BMI) as an assessment tool and showed a significant decrease in BMI following electroacupuncture treatment. There were 4 studies using waist circumference as an indicator of abdominal obesity and these studies showed a significant decrease in waist circumference following electroacupuncture treatment. Electroacupuncture treatment used in primary obese women had a clinically significant effect, however, further RCT are needed.



## Introduction

Obesity poses a threat to human health and is associated with coronary vascular disease, hypertension, stroke, insulin-dependent diabetes, cancer, gallbladder disease, dyslipidemia, osteoarthritis, gout, and respiratory disease [1]. Obesity is also a factor which increases the risk of polycystic ovarian syndrome, endometrial cancer, breast cancer and colon cancer in women, and can affect fertility and diseases related to hormones or reproductive function [2]. Obesity is a disease that can affect not only the physical and mental health of a patient, but can affect society [3].

According to the Korea National Health and Nutrition Examination Survey in 2018, the prevalence of obesity for women over 19 years of age [% of people with a body mass index (BMI) of > 25 kg/m$^2$] was 25.5% and the prevalence of obesity increased with age, reaching 43.0% for those over 70 years of age [4]. Treatment of women's obesity in an aging Korean society is important for improving health, given that the BMI of women positively correlates with the risk of cardiovascular disease after menopause [5].

In Western medicine, orlistat, lorcaserin, phentermine are used as obesity treatments, but there are only a few safe and effective obesity treatments, so it is necessary to develop new treatment options [6]. Sleeve gastrectomy and Roux-en-Y gastric bypasses are surgical methods frequently carried out in Korea, but postoperative complications may lead to a lack of nutrients such as iron, calcium, and vitamin D [7].

In Korean medicine, obesity is perceived as a condition of

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dampness and phlegm due to differences in biopsychological personality and lack of healthcare. Herbal medicine, acupuncture, auricular acupuncture, electroacupuncture, pharmacopuncture, moxibustion, cupping, needle-embedding therapy, Chuna, physical therapy, diet, and exercise instruction are used as treatment methods for obesity [8-12]. Amongst them, electroacupuncture is a therapy used to improve metabolism and reduce edema by increasing the temperature of local tissues using electrical stimulus by passing through needles [13]. There are a variety of electroacupuncture studies, but the number of these studies for the treatment of obesity in women is limited. In this study, we reviewed the effects of electroacupuncture in obese women and evaluated its use to aid future research into this area.

## Materials and Methods

### *Selection and exclusion criteria*

Randomized controlled trials (RCT) conducted in women with "primary obesity" were selected for this study and the intervention was electroacupuncture (with "other treatments" if performed in the control group). The diagnosis of obesity can be classified into primary and secondary, depending on the cause. Primary obesity is caused by an imbalance in energy intake and consumption due to abnormal eating and living habits in the absence of specific diseases that may have caused the obesity. Secondary obesity is caused by genetics, drugs, and endocrine diseases [14]. Control groups and evaluation indices were not restricted.

The exclusion criteria were ① duplicate studies, ② studies which were not RCT, ③ studies without full text, ④ studies not published in academic journals, ⑤ previously published studies by the same author, ⑥ studies that did not perform "other treatments" besides electroacupuncture in the control group and treatment group, ⑦ studies not related to obesity, ⑧ studies not exclusively in women.

### *Databases and search methods*

Using the Cochrane Library, Embase, PubMed, China Academic Journal (CAJ), Korean Studies Information Service System (KISS), Research Information Sharing Service (RISS), and Oriental Medicine Advanced Searching Integrated System (OASIS), studies were retrieved up to December 28th, 2019.

The search terms were "electroacupuncture and obese and woman" in Cochrane Library, Embase, and PubMed, and in CAJ the search terms were "electroacupuncture and obesity," and "women" in the title. In KISS, RISS, and OASIS, the search term was "electroacupuncture and obesity."

## Results

### *Study selection*

There were 23 studies retrieved from the Cochrane Library, 35 from Embase, 25 from PubMed, 8 from CAJ, 10 from KISS, 14 from RISS, and 11 from OASIS. A total of 126 studies were retrieved amongst which, 48 studies were duplicates. There were 43 out of 78 studies selected considering their titles and abstracts, excluding 24 non-RCT studies, 4 studies without full text, 5 dissertations, and 2 studies similar to previously published studies by the same author. Subsequently, a total of 6 studies were selected out of the 43 studies considering abstracts or full text, with the additional exception of 22 studies where the effectiveness of electroacupuncture was not clear, 11 studies not related to obesity, and 4 studies not exclusively women (Fig. 1).

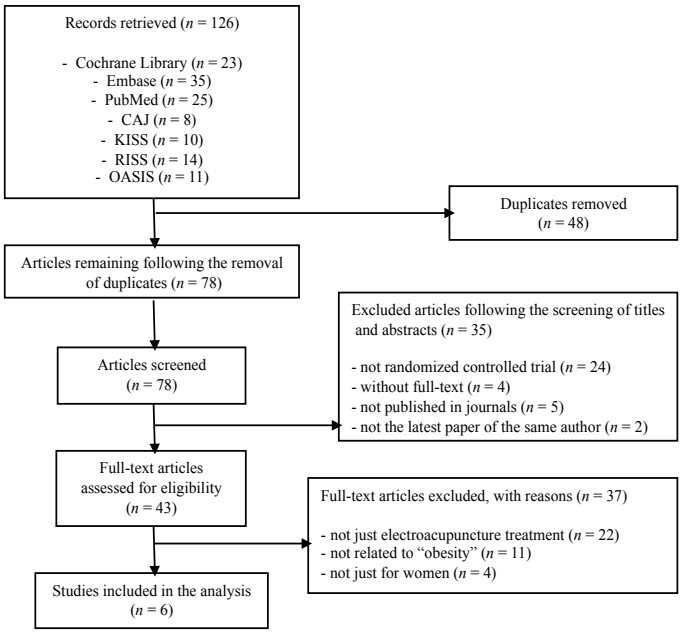


Fig. 1. Flow chart of screening process.

### *The overview of selected studies*

The 6 selected studies for review were retrieved from Embase, PubMed, and CAJ, and published between 2005 and 2017. RCT were conducted in China ($n$ = 3), Taiwan ($n$ = 2) and Egypt ($n$ = 1). These studies were reported in English or Chinese.

A total of 306 women with "primary obesity" were included in this review from participants of the 6 included studies. The study with the highest number of participants included 102 individuals, whereas other studies contained mostly 40-50 individuals, however the smallest number was 30.

In all 6 studies, there were criteria for selection and exclusion of participants, and BMI [15-19] or waist circumference (WC) [15,17,19,20] was mainly used for the diagnosis criteria of obese women. In all studies, there were no statistically significant differences between the characteristics of the treatment group and the control group before the introduction of the intervention. However, in the study of Hsu et al [15] of 54 obese women, the mean WC of treatment group was significantly larger than control group. For the study of El-Kader and Khalifa [16], there were no significant differences between the 2 groups (Table 1).

### *The Interventions of selected studies*

Among the 6 selected studies, 4 studies had electroacupuncture as a single intervention [15,18-20] and 2 studies combined electroacupuncture with other treatments [16,17]. El-Kader and Khalifa [16] used exercise and diet meals together with electroacupuncture treatment, and Wu et al [17] used a weak laser fat dissolution technique together with electroacupuncture treatment. In 4 studies, where electroacupuncture was a single intervention, there were 2 studies with no treatment in the control group, 1 study with general acupuncture [18] and 1 study with exercise [15]. As an intervention of the control group, El-Kader and Khalifa [16] had exercise and diet meals with intradermal

Table 1. General Characteristics of Selected Studies.

| Author (y) | Type | Country | Sample size | Criteria | Mean ± SD (y) | BMI (± SD) | WC (± SD) |
|---|---|---|---|---|---|---|---|
| Hsu (2005) [15] | RCT | Taiwan | TG 24<br>CG 22 | · 16-65 y<br>· BMI > 30 kg/m²<br>· WC > 90 cm<br>· No disease to affect obesity | TG 41.5 (11.2)<br>CG 41.0 (10.0) | TG 33.6 (3.3)<br>CG 33.2 (4.0) | TG 97.2 (6.5)*<br>CG 94.6 (6.7) |
| Lin (2010) [20] | RCT | Taiwan | TG 20<br>CG 21 | · < 64 y<br>· Body fat > 30%<br>· WC > 80 cm<br>· No disease to affect obesity | TG 54.05 ± 3.44<br>CG 56.05 ± 3.11 | - | TG 86.45 ± 7.47<br>CG 86.29 ± 5.71 |
| El-Kader (2012) [16] | RCT | Egypt | TG 20<br>CG 20 | · BMI > 30 kg/m²<br>· No disease to affect obesity | From 20 to 35 | TG 33.59 ± 6.40<br>CG 33.82 ± 5.34 | - |
| Wu (2015) [17] | RCT | China | TG 25<br>CG 22 | · 18-60 y<br>· BMI > 23 kg/m²<br>· WC > 80 cm<br>· Body fat > 35%<br>· 20% of women's standard weight < BW<br>· No disease to affect obesity | TG 35 ± 8<br>CG 37 ± 8 | TG 29.35 ± 5.6<br>CG 28.42 ± 4.01 | TG 90.18 ± 12.17<br>CG 88.57 ± 10.87 |
| Han (2015) [18] | RCT | China | TG 54<br>CG 48 | · 18-50 y<br>· 25 < BMI < 40 kg/m²<br>· 20% of women's standard weight < BW < 100 kg<br>· No disease to affect obesity | TG 32.86 ± 13.08<br>CG 31.17 ± 14.20 | TG 30.93 ± 2.96<br>CG 30.88 ± 2.01 | - |
| Lei (2017) [19] | RCT | China | TG 15<br>CG 15 | · 21-53 y<br>· BMI > 23 kg/m²<br>· WC > 80 cm<br>· No disease to affect obesity | TG 31.6 ± 8.2<br>CG 31.4 ± 8.4 | TG<br>23 ≤ BMI < 25 ($n$ = 4)<br>25 ≤ BMI < 30 ($n$ = 7)<br>BMI ≥ 30 ($n$ = 4)<br>CG<br>23 ≤ BMI < 25 ($n$ = 4)<br>25 ≤ BMI < 30 ($n$ = 8)<br>BMI ≥ 30 ($n$ = 3) | No exact figures |

*Statistically significant.
BMI, body mass index; BW, body weight; CG, control group; SD, standard deviation; RCT, randomized controlled trial; TG, treatment group; WC, waist circumference.

needle therapy, and Wu et al [17] had weak laser fat dissolution treatment. As daily life management, 2 studies allowed the usual diet, exercise, and lifestyle [15,19], while other studies did not make reference to this (Table 2).

The treatment was performed mostly between 2 [15,20] to 3 times a week [16,19]. The duration of treatment was mostly 3 months [16,19], with the range between 6 weeks to 3 months. There were 5 studies where electroacupuncture was symmetrically applied to both sides of the body [15-19], and 1 study with application to 1 side of the body [20]. The length of the needle i.e. the depth that the needle is inserted, whether to use De-qi, the electroacupuncture machine used, and the form of electric stimulus varied from study to study (Table 3).

The treatment group could be classified according to the application area of electroacupuncture. There were 3 studies where electroacupuncture was applied to the abdomen [15,16,19], 2 studies applied it to both the abdomen and lower body [17,18], and 1 study where it was applied to lower body (Table 3) [20]. The acupoints most used for applying electricity were ST36 [17,18,20] and CV6 [16-18] which were used in 3 studies, and CV12, ST25, and ST40 were used as the "other" acupoints (Table 4). Considering the frequency of use of each acupoint for electroacupuncture, the most used meridian was the Stomach meridian, followed by the Conception vessel and Spleen meridian (Table 5).

### *Treatment effects in obesity assessment indicators*

BMI

BMI was evaluated in 5 of the 6 studies as the rate of decrease in BMI in the group. In the study of Hsu et al [15], the rate of decrease in BMI of the electroacupuncture treatment group was statistically significantly reduced compared with the group that exercised The study of El-Kader and Khalifa [16] study showed a significant rate of decrease in BMI in the electroacupuncture treatment group and the intradermal needle therapy group compared with control groups, however there was no statistical difference between the electrotherapy and needle therapy groups. In the study of Wu et al [17], the electroacupuncture group together with laser treatment showed a statistically significantly reduced rate of BMI for the 3 periods of treatment tested, compared with the laser treatment

Table 2. Interventions and Results of Selected Studies.

| Author (y) | Intervention | Control | Routine managementment | Outcome measurement | Result | Adverse effect |
|---|---|---|---|---|---|---|
| Hsu (2005) [15] | EA | Sit-up exercise | Allowed | 1. Reduction in body weight<br>2. Reduction in BMI<br>3. Reduction in WC | 1. TG > CG ($p = 0.001$)<br>2. TG > CG ($p = 0.003$)<br>3. TG > CG ($p = 0.005$) | No severe events |
| Lin (2010) [20] | EA | No treatment | Not reported | < Body composition ><br>1. Reduction in body weight<br>2. Reduction in WC<br>3. Reduction in hip circumference<br>4. Reduction in the percentage of body fat<br>5. An increase of the percentage of LBM<br>< Meridian system ><br>Meridian performance variances | < Body composition ><br>1. TG > CG ($p < 0.05$)<br>2. TG > CG ($p < 0.001$)<br>3. TG > CG ($p < 0.001$)<br>4. TG > CG ($p < 0.003$)<br>5. TG > CG ($p < 0.003$)<br>< Meridian system ><br>No statistically significant differences<br>except Left triple burner meridian | Not reported |
| El-Kader (2012) [16] | EA (+ Physical training, dietary measures) | Intracutaneous pressing needles (+ Physical training, dietary measures) | Not reported | 1. Reduction in BMI<br>2. Reduction in serum leptin levels<br>3. Reduction in serum TC levels<br>4. Improvement in serum HDL levels<br>5. Reduction in serum LDL levels<br>6. Reduction in serum TG levels<br>7. Improvement in self-esteem (RSES) (questionnaire)<br>8. Reduction in depression (BDI) (questionnaire)<br>9. Reduction in total mood disturbance (POMS) (questionnaire) | No statistically significant differences | No |
| Wu (2015) [17] | EA + Weak laser fat dissolution technique | Weak laser fat dissolution technique | Not reported | 1. Reduction in body weight<br>2. Reduction in BMI<br>3. Reduction in WC<br>4. Reduction in abdominal circumference<br>5. Reduction in hip circumference<br>6. Reduction in body fat percentage (F %)<br>7. Reduction in VFI | 1. TG > CG ($p < 0.01$)<br>2. TG > CG ($p < 0.05$)<br>3. TG > CG ($p < 0.05$)<br>4. TG > CG ($p < 0.05$)<br>5. TG > CG ($p < 0.05$)<br>6. No difference<br>7. TG > CG ($p < 0.05$) except 1st session | No |
| Han (2015) [18] | EA | Acupuncture | Not reported | 1. Reduction in BMI<br>2. An increase in the clinically curative effect rate<br>3. Decrease in the score of TCM symptom integral of spleen dysfunction and dampness syndrome | 1. TG > CG ($p < 0.05$)<br>2. TG > CG ($p < 0.05$)<br>3. TG > CG ($p < 0.05$) | No |
| Lei (2017) [19] | EA | No treatment | Allowed | 1. Reduction in BMI<br>2. Reduction in WC<br>< Abdominal MRI scan ><br>1. Reduction in VAT volume<br>2. Reduction in mean HFF | 1. TG > CG ($p < 0.001$)<br>2. TG > CG ($p = 0.002$)<br>< MRI scan ><br>1. TG > CG ($p < 0.001$)<br>2. TG > CG ($p < 0.001$) | Not reported |

BDI, beck depression inventory; BMI, body mass index; CG, control group; EA, electroacupuncture; HDL, high density lipoprotein cholesterol; HFF, hepatic fat fraction; LBM, lean body mass; LDL, low density lipoprotein cholesterol; MRI, magnetic resonance imaging; POMS, profile of mood states; RSES, Rosenberg self-esteem scale; TC, total cholesterol; TCM, traditional Chinese medicine; TG, triglyceride; TG, treatment group; VAT, visceral adipose tissue; VFI, visceral fat index; WC, waist circumference.

group alone. In the study of Han et al [18], there was a statistically significant decrease in the rate of BMI in the electroacupuncture group compared with the general acupuncture group. The study of Lei et al [19] did not provide actual figures for BMI changes, but there was a statistically significant rate of decrease in BMI in the electroacupuncture group compared with the no-treatment group (Table 6).

WC

WC was evaluated in 4 of the 6 studies. In the study of Hsu et al [15], the electroacupuncture group had a statistically significant reduction in WC compared with the exercise group. In the study of Lin et al [20], the electroacupuncture group showed a statistically significant decrease in WC compared with the general acupuncture group. In the study of Wu et al [17], the electroacupuncture group combined with laser treatment had a statistically significant decrease in WC compared with the laser treatment group alone, and differences were maintained during the 3 periods of treatment . In the study of Lei et al [19], the electroacupuncture group had a statistically significant decrease in WC compared to the no-treatment group (Table 7).

Hip circumference

The hip circumference was evaluated in 2 of the 6 studies. In

Table 3. Implementation of Electroacupuncture Intervention.

| Author (y) | Period | Electroacupuncture Frequency | Acupoints | Side | Size of needles | Depth of insertion | Deqi | Wave form |
|---|---|---|---|---|---|---|---|---|
| Hsu (2005) [15] | 6 wk | 2 × wk for 40 min | < Abdomen applying EA > ST28*, K14*, REN6*, REN9* < Extremity > ST26, ST40, SP6 | Both | 34 gauge × 38 mm | 25 mm | Yes | 42 Hz, 12-23 V, dense-disperse wave |
| Lin (2010) [20] | 12 wk | 2 × wk for 20 min | ST36*, SP6* | Single sided | Not reported | Not reported | Not reported | 4000 Hz + 61 Hz, 0-25 V, 50 mA, 125 uA wave |
| El-Kader (2012) [16] | 3 mon | 3 × wk for 50 min | < Abdomen > CV6, CV10, CV12, CV13, SP15, ST25 | Both | 5.8-76 mm × 2.0-3.0 inches | 25 mm | Yes | 3 Hz, 15 mA, 0.05 ms square wave |
| Wu (2015) [17] | 3 session | Every other day 10 × a session for 30 minutes | 1) ST21, ST25, ST27, ST28, ST34, ST36, SP15, LI11, CV4, CV12 2) ST24, ST37, ST39, ST40, ST44, GB26, LI4, SP6, CV6, CV10 | Both | 0.30 × 40-50 mm | Not reported | Yes | continuous wave |
| Han (2015) [18] | 8 wk | 5 × wk for 30 min | CV6*, CV10, CV12*, ST25, ST36*, ST40*, GB26, GB34 | Both | 0.30 × 40-60 mm | 30-50 mm | Yes | dense-disperse wave |
| Lei (2017) [19] | 3 mon | 3 × wk for 30 min | < Abdomen > ST24*, ST25, ST26, ST28*, SP14*, SP15*, REN4, REN9 < Extremity > ST36, ST40, ST44, GB34, TE6 | Both | 0.25 × 30 mm | 25 mm | Yes | 50 Hz, 6 V, 0.5 ms continuous wave |

*Acupoints connected to the electrical instrument.
CV, conception vessel; EA, electroacupuncture; GB, gallbladder meridian; K, kidney meridian; LI, large intestine meridian; REN, ren meridian; SP, spleen meridian; ST, stomach meridian; TE, triple energizer meridian.

Table 4. Frequency of Acupoints Connecting the Electrodes Used in the Studies.

| Frequency | Acupoints |
|---|---|
| 3 | ST36, CV6 |
| 2 | CV12, ST25, ST40 |
| 1 | CV9, CV10, CV13, ST28, ST37, ST44, SP15, SP6, K14 |

CV, conception vessel; K, kidney meridian; SP, spleen meridian; ST, stomach meridian.

Table 5. Frequency of Meridians Connecting the Electrodes Used in the Studies.

| Frequency | Meridians | Acupoints |
|---|---|---|
| 10 | Stomach meridian | ST25, ST28, ST36, ST37, ST40, ST44 |
| 8 | Conception vessel | CV6, CV9, CV10, CV12, CV13 |
| 2 | Spleen meridian | SP15, SP6 |
| 1 | Kidney meridian | K14 |

CV, conception vessel; K, kidney meridian; SP, spleen meridian; ST, stomach meridian.

Table 6. The Outcome of Body Mass Index (BMI) in the Studies.

| Author (y) | Treatment | Control | *p* |
|---|---|---|---|
| Hsu (2005) [15] | EA -2.3 ± 3.7 (%) | PE -0.5 ± 1.7 (%) | 0.003 |
| El-Kader (2012) [16] | EA 30.25 ± 5.61 (kg/m²) | IN 31.88 ± 5.14 (kg/m²) | 0.94 |
| Wu (2015) [17] | 1st EA + LA -1.41 ± 1.51 (kg/m²) | LA -0.57 ± 0.39 (kg) | < 0.05 |
| | 2nd EA + LA -1.02 ± 0.77 (kg/m²) | LA -0.50 ± 0.33 (kg) | < 0.01 |
| | 3rd EA + LA -1.11 ± 0.71 (kg/m²) | LA -0.62 ± 0.93 (kg) | < 0.05 |
| Han (2015) [18] | EA 26.07 ± 1.53 (kg/m²) | Acu 28.31 ± 1.99 (kg/m²) | < 0.05 |
| Lei (2017) [19] | EA > NT | | < 0.001 |

Acu, acupuncture; EA, electroacupuncture; IN, intracutaneous needle; LA, laser; NT, no treatment; PE, physical exercise.

the study of Lin et al [20], the electroacupuncture group showed statistically significant reductions in hip circumference compared with the no-treatment group. In the study of Wu et al [17], both the electroacupuncture group combined with laser treatment and laser treatment group showed significant hip circumference reductions in 3 periods, however, the electroacupuncture group with laser treatment was statistically significantly less than the laser treatment group (Table 8). Wu et al [17] measured abdominal circumference as well as waist and hip circumference, and the electroacupuncture group with laser treatment had a statistically significant lower abdominal circumference compared with the laser treatment group alone.

Body and visceral fat

Three of the 6 studies evaluated changes in fat. Lin et al [20] evaluated body fat, Lei et al [19] evaluated visceral fat, and Wu et al [17] evaluated both body fat and visceral fat. In the study of Lin et al [20], only the electroacupuncture group showed a statistically significant reduction in body fat percentage, compared to the no-treatment group. The study of Wu et al [17] showed that the electroacupuncture group combined with laser treatment had a higher but not statistically significant reduction in body fat compared with the laser treatment group alone after all 3 treatment periods. In addition, Wu et al [17] observed that the percentage of visceral fat was reduced further in the electroacupuncture group combined with laser treatment compared with the laser treatment alone group, but there were no statistically significant differences in the first period, followed by statistically significant differences in the second and third period. Lei et al [19] used magnetic resonance imaging scans to view visceral fat between L4-S3 by integral calculus, and the hepatic fat fraction was obtained by using the difference in shading of 3 selected different regions of interest in the liver. The ratio of visceral and liver fat was statistically significantly reduced in the electroacupuncture group. On the contrary, the ratio of visceral and liver fat increased over the period of the RCT in the no-treatment group. The differences between the 2 groups were statistically significant (Table 9) [19].

Table 7. The Outcome of Waist Circumference (WC) in the Studies.

| Author (y) | Treatment | Control | *p* |
|---|---|---|---|
| Hsu (2005) [15] | EA -2.1 ± 1.8 (%) | PE -0.9 ± 1.8 (%) | 0.005 |
| Lin (2010) [20] | EA 84.85 ± 7.96 (cm) | Acu 86.26 ± 5.40 (cm) | 0.001 |
| Wu (2015) [17] | 1st EA + LA -3.70 ± 2.71 (cm) | LA -1.86 ± 1.07 (cm) | < 0.01 |
| | 2nd EA + LA -2.76 ± 2.57 (cm) | LA -1.34 ± 1.03 (cm) | < 0.05 |
| | 3rd EA + LA -2.48 ± 1.79 (cm) | LA -1.52 ± 1.36 (cm) | < 0.05 |
| Lei (2017) [19] | EA > NT | | 0.002 |

Acu, acupuncture; EA, electroacupuncture; LA, laser; NT, no treatment; PE, physical exercise.

Table 8. The Outcome of Hip Circumference in the Studies.

| Author (y) | Treatment | Control | *p* |
|---|---|---|---|
| Lin (2010) [20] | EA 99.00 ± 5.49 (cm) | NT 101.71 ± 5.34 (cm) | < 0.001 |
| Wu (2015) [17] | 1st EA + LA -2.72 ± 2.05 (cm) | LA -1.50 ± 0.93 (cm) | < 0.05 |
| | 2nd EA + LA -2.18 ± 1.74 (cm) | LA -1.07 ± 1.03 (cm) | < 0.05 |
| | 3rd EA + LA -2.22 ± 1.63 (cm) | LA -1.20 ± 0.95 (cm) | < 0.05 |

EA, electroacupuncture; LA, laser; NT, no treatment.

Table 9. The Outcome of Body and Visceral Fat in the Studies.

| | Author (y) | Treatment | Control | *p* |
|---|---|---|---|---|
| Body fat | Lin (2010) [20] | EA 32.91. ± 3.75 (%) | NT 37.66 ± 4.67 (%) | < 0.001 |
| | Wu (2015) [17] | 1st EA + LA -1.08 ± 0.86 (%) | LA -0.66 ± 0.67 (%) | NS |
| | | 2nd EA + LA -1.16 ± 0.80 (%) | LA -0.75 ± 0.73 (%) | NS |
| | | 3rd EA + LA -1.52 ± 1.21 (%) | LA -0.99 ± 1.10 (%) | NS |
| Visceral fat | Wu (2015) [17] | 1st EA + LA -1.00 ± 1.12 (%) | LA -0.82 ± 1.10 (%) | NS |
| | | 2nd EA + LA -1.04 ± 1.17 (%) | LA -0.50 ± 0.51 (%) | < 0.05 |
| | | 3rd EA + LA -1.28 ± 0.93 (%) | LA -0.50 ± 0.60 (%) | < 0.05 |
| | Lei (2017) [19] | EA > > NT (increase) | | < 0.001 |

EA, electroacupuncture; LA, laser; NS, not significant; NT, no treatment.

Table 10. The Outcome of Bodyweight in the Studies.

| Author (year) | Treatment | Control | *p* |
|---|---|---|---|
| Hsu (2005) [15] | EA -1.8 ± 2.0 (%) | PE -0.4 ± 1.7 (%) | 0.001 |
| Lin (2010) [20] | EA 63.14 ± 10.27 (kg) | NT 67.02 ± 7.18 (kg) | < 0.05 |
| Wu (2015) [17] | 1st EA + LA -2.79 ± 1.81 (kg) | LA -1.09 ± 0.74 (kg) | < 0.01 |
| | 2nd EA + LA -2.40 ± 1.78 (kg) | LA -1.17 ± 0.81 (kg) | < 0.01 |
| | 3rd EA + LA -2.78 ± 1.56 (kg) | LA -0.92 ± 0.52 (kg) | < 0.01 |

EA, electroacupuncture; LA, laser; NT, no treatment; PE, physical exercise.

Bodyweight

Weight loss was evaluated in 3 of the 6 studies. In the study of Hsu et al [15], the electroacupuncture group showed a statistically significant higher rate of weight loss compared with the group that exercised. In the study of Lin et al [20], the electroacupuncture group had statistically significant weight losses compared with the control group without treatment. In addition, Lin et al [20] evaluated lean body mass (LBM), and showed a statistically significant decrease in LBM in the electroacupuncture group compared with the no-treatment group. In the study of Wu et al [17], treatments were conducted over 3 periods. The electroacupuncture group combined with laser treatment showed a statistically significant greater weight loss than the laser treatment group alone (Table 10).

Other indicators

Other evaluation indicators included electrical conductivity of meridians, levels of lipids and leptin in the blood, self-esteem and depression, clinical efficiency, traditional Chinese medicine symptom scores, and mental health indices such as total emotional disability scores. The electrical conductivity of the meridian was measured using a specific device used to measure electrical conductivity. Electrical conductivity of the Triple burner meridian measured on the left arm after electroacupuncture had statistically significantly increased conductivity compared with the no-treatment group ($p < 0.05$). Lin et al [20] reported that middle-frequency electric stimulus elevated lack of Yang energy of postmenopausal women and it caused changes in local metabolism. The study of El-Kader and Khalifa [16] showed that serum levels of triglyceride (TG), total cholesterol (TC), low-density lipoprotein (LDL) cholesterol, leptin, Beck depression inventory, and Profile of Mood States were statistically significantly reduced in both the electroacupuncture group and intradermal needle therapy group. On the contrary, the levels of high-density lipoprotein (HDL) cholesterol and Rosenberg self-esteem scale were statistically significantly increased, but there were no statistically significant differences between the 2 groups [16]. Han et al [18] evaluated the effects of electroacupuncture in obese women with spleen dysfunction and dampness syndrome by using traditional Chinese medicine symptom scores and clinical efficiency of BMI changes ($p < 0.05$).

*Adverse events*

No side effects were observed in 3 of the 6 studies [16-18], and there was no mention of side effects in 2 studies [19,20]. The study of Hsu et al [15] reported mild ecchymosis and abdominal discomfort after electroacupuncture treatment, but no serious side effects were observed.

## Discussion

Abnormal weight gain in adults generally occurs between the 20s to 60s. Men tend to gain weight in their early years, and women tend to gain weight after the menopause [20] and mainly build up fat in the abdomen and buttocks [21]. The 2018 obesity prevalence rate (% of people with a BMI > 25 kg/m$^2$) reported by the Ministry of Health and Welfare, showed that the prevalence rate of obesity in women increased with age (there were 16.2% in their 20s, 22.6% in their 30s, 25.7% in their 40s, 29.3% in their 50s and 35.5% in their 60s) [4].

Obesity is generally a risk factor for high blood pressure, diabetes, and cardiovascular disease [1]. Women may experience ovarian dysfunction caused by endocrine dysfunction, irregular menstruation, infertility, and miscarriage. It has been reported that ovarian hormones may be absorbed by adipose tissue, which can lead metabolism to becoming abnormal, and increased levels of ovarian hormones may stimulate the breast, and thereby promote breast cancer [22,23]. Therefore, it is necessary to study treatment for obesity in women with biological differences in physique, basal metabolic rate, and stage of life [24].

There is a wide variety of obesity treatments based on diet, exercise, drugs and surgery (Western medicine), and in traditional Korean medicine there is herbal medicine, acupuncture, moxibustion, and constitutional therapy [24]. In oriental medicine, obesity is recognized as a condition of dampness and phlegm due to a lack of healthcare and a poor physical constitution. In Danxi xinfa, Zhu Danxi said that obesity can cause irregular menstruation or infertility, and therefore dampness and phlegm should be eliminated in the treatment of obesity [25]. Electroacupuncture is a treatment that applies both mechanical and electric stimulation to the acupoint by passing a current through the needle. By increasing the temperature of local tissues with rhythmic contraction of the stimulated muscles, metabolism can be improved and stagnant body fluids can circulate [13].

There have been no reviews to date of RCT that used electroacupuncture treatment for obese women. A review by Nam [26] analyzed the overall effects of herbal treatment, acupuncture, moxibustion, and needle-embedding therapy for postmenopausal obese women. In 2 selected RCT on electroacupuncture treatment, auricular acupuncture or scraping therapy was conducted in the electroacupuncture group, but the control group did not have auricular acupuncture or scraping therapy, so the single effect of electroacupuncture treatment could not be identified. In addition, 1 study compared the effects of the application site, rather than identifying the effects of the electroacupuncture [26].

This current study aimed to evaluate the clinical effects of electroacupuncture treatment on women diagnosed with "primary obesity," by examining RCT worldwide. A total of 126 studies were retrieved through 7 databases, and 6 studies were selected for analysis according to the inclusion/exclusion criteria.

The diagnosis of obesity can be classified into primary and secondary, depending on the cause. Primary obesity is caused by an imbalance in energy intake and consumption due to abnormal eating and living habits in the absence of specific diseases that may have caused obesity. Secondary obesity is caused by genetics, drugs,

and endocrine diseases [14]. The clinical guidelines for obesity in 2018, provided by Korean Society for the Study Of Obesity, to set the category of adult obesity above a BMI of 25 kg/m², classifying obesity as Class I (25.0-29.9 kg/m²), Class II (30-34.9 kg/m²), or Class III (above 35.0 kg/m²). Abdominal obesity is determined by a WC of 90 cm or more in men and 85 cm or more in women [27]. In the 6 selected studies, the criteria for selecting participants and the indicators for assessing obesity were different for each study. For example, female BMI considered to indicate obesity was 23 kg/m² or higher [17,19], or 30 kg/m² or higher [15,16], with some studies ranging from 25 kg/m² to 40 kg/m² [18]. The female WC considered to represent obesity in the selected studies was mostly over 80 cm [17,19,20], with the study of Hsu et al [15] over 90 cm. In the selected studies, all participants were women with "primary obesity" by excluding participants with specific diseases likely to cause obesity.

To find out the single effect of the electroacupuncture treatment in "primary obese" women, studies in which treatments other than electroacupuncture were not performed in the control group were excluded. The intervention of the treatment group was electroacupuncture, and treatments other than electroacupuncture were performed in 2 studies [16,17]. El-Kader and Khalifa [16] performed the electroacupuncture treatment combined with exercise and diet meals, while Wu et al [17] performed electroacupuncture combined with a weak laser fat dissolution technique, and weak laser fat dissolution was carried out in the control group. So, the effectiveness of the electroacupuncture could be identified. Since there were no restrictions on the control groups, there were various kinds of groups, such as no-treatment [19,20], exercising [15], intracutaneous pressing needles [16], and laser treatment [17].

The results of the electroacupuncture for "primary obese" women showed a statistically significant decrease in BMI in 4 of 6 studies [15,17-19], and statistically significant reductions in WC in another 4 studies [15,17,19,20]. In the study of El-Kader and Khalifa [16], BMI, serum total TC, TG, LDL cholesterol, and leptin levels decreased, while HDL cholesterol increased, but there were no statistically significant differences between the treatment group and control group. However, the study of Cabioglu and Ergene in 2005 [28], excluded from the selection due to the combination of electroacupuncture and auricular acupuncture therapy for obese women, had statistically significant reductions in TG, TC, and LDL cholesterol, without any statistically significant differences in serum HDL changes. In a 2006 study, Cabioglu and Ergene [29] also reported that the electroacupuncture group showed a statistically significant decrease in serum leptin compared to the control group. According to Han et al [30], low-frequency electroacupuncture increases serum β-endorphin with lipolysis activity. If the adipose tissues are decomposed by β-endorphin, energy consumption may increase and appetite may be suppressed by reduced serum leptin, a hormone secreted by adipose tissues. In other words, when the adipose tissues are decomposed by β-endorphin, which is increased by the electroacupuncture treatment, a decrease in physiological indicators such as serum TG, TC, LDL cholesterol, and leptin, results in weight loss [29]. Further clinical studies are needed on physiological changes caused by the electroacupuncture treatment.

There was a statistically significant decrease in the amount of fat in 2 [19,20] out of the 3 studies [17,19,20] that identified the percentage change in fat levels. Wu measured both body and visceral fat percentages. Although there were no statistically significant differences in body fat reduction between the electroacupuncture and control groups, until the second period of treatment where the reduction in visceral fat was statistically significantly different to the control group. This means that the change in visceral fat is slower than other indicators, and visceral fat decreases gradually [17]. Electroacupuncture treatment may affect the activation of fat metabolism, but further study is needed. In Lei's study using magnetic resonance imaging scans, BMI, and WC of the no-treatment group did not increase, but abdominal and liver fat increased. If the fat becomes excessive, free fatty acids are deposited into internal organs rather than subcutaneous tissue. However, it is not immediately reflected in changes in bodyweight or WC, so it is worth paying more attention to changes in abdominal fat in terms of long-term health care [19].

In the selected studies, the electroacupuncture treatment was mainly applied to the abdomen or lower body. The acupoints where the electrical stimulation was most frequently applied are ST36 (Zusanli) and CV6 (Qihai). The meridians most frequently used were Stomach meridian, followed by Conception vessel and Spleen meridian. ST36 (Zusanli) was used for the treatment of dampness and phlegm as 1 of the meridian points of Stomach meridian, because the excessive dampness damages the stomach and spleen [31]. CV6 (Qihai) is 1 of the meridian points of Conception vessel located in the abdomen and promotes the movement of body fluids [32].

There were no adverse effects in 3 out of the 6 studies [16-18], and nothing was reported in the rest of the studies, except for those with a mild ecchymosis and abdominal discomfort [15].

The limitations of this study were that the number of selected studies was small, the quality of the literature was not assessed, and the evaluation indicators of each study were not unified. However, the results of this study showed that electroacupuncture treatment can have a significant effect and is a safe treatment for "primary obese" women. In the future, it is necessary to confirm the effectiveness of electroacupuncture treatment in obese women and establish the mechanisms of electroacupuncture treatment through clinical research on various physiological indicators.

## Conclusion

1. A total of 126 studies were retrieved from 7 databases, and a total of 6 studies were selected according to the inclusion/exclusion criteria.
2. In the 6 selected studies, the intervention treatment was electroacupuncture, compared to no-treatment, general acupuncture, intradermal needle, exercise, or laser treatment.
3. The BMI of the electroacupuncture groups was statistically significantly lower than the control groups in 4 studies, and in 4 studies, the WC of the electroacupuncture groups was statistically significantly lower than the control groups.
4. There were no adverse events in 3 studies, and no serious adverse events in 1 study.
5. Further clinical studies are needed in the future to determine the effects of electroacupuncture treatment for "primary obese" obese women.

## Conflicts of Interest

The authors have no conflicts of interest to declare.

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