Effects of Laser Acupuncture and Dietary Intervention on Key Obesity Parameters

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ABSTRACT

Objectives: The scope of obesity includes quality of life (QoL); emotions; and financial burdens on individuals, families, and society. Obesity contributes to many diseases, such as coronary heart disease, type 2 diabetes, stroke, osteoarthritis, and cancer. Dietary modifications, lifestyle interventions, pharmacologic agents, and surgical interventions are some ways to address obesity; yet, safer, more-effective options are needed. Laser acupuncture can significantly lower body mass index (BMI) by reducing abdominal and visceral adipose tissue content and regulating lipid metabolism. This study investigated the effects of laser acupuncture + diet modification on fasting blood-glucose level, insulin level, waist:hip ratio, QoL scoring, high-density lipoprotein (HDL) level, triglycerides, BMI, and appetite scoring in obese patients.

Materials and Methods: The patients ($N=38$) were divided randomly into 2 groups: (1) laser acupuncture + dietary intervention ($n=19$) and (2) sham laser acupuncture + dietary intervention ($n=19$). Both groups had the same dietary intervention and laser acupuncture sessions, 3 times/week for 4 weeks. All parameters were assessed before and after the interventions.

Results: There were statistically significant differences in waist:hip ratio ($P=0.000$), QoL scores ($P=0.000$), BMI ($P=0.000$), and appetite scores ($P=0.000$) between the 2 groups after the interventions. There were no differences in levels of blood glucose ($P=0.543$), insulin ($P=1.00$), HDL ($P=0.208$), and triglycerides ($P=0.413$) between the 2 groups after the interventions.

Conclusions: Combining laser acupuncture and a dietary intervention has good effects on waist:hip ratio, QoL scores, BMI, and appetite scores in obese patients.

Keywords: laser acupuncture, blood glucose, waist:hip ratio, high-density lipoprotein, body mass index, obese

INTRODUCTION

OBESITY IS A MULTIFACTORIAL CONDITION that results from accumulation of excessive fat tissue. This problem occurs in all countries in the world, including Indonesia. Obesity develops due to changes in people's lifestyles, including physical activity and eating patterns influenced by

the socioeconomic status of the community in which an individual resides.¹ Obesity is a risk factor for degenerative diseases in developing countries and there is a lack of success in managing it around the world.² According to the nutritional status report data for outpatients in the Cipto Dr. Mangunkusumo Hospital (RSCM) in Central Jakarta in 2017, there was a total of 582 obese patients, with the

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geriatric unit having 24 patients, the pediatric unit having 75 patients, and the Kencana outpatients clinic having 182 patients. It can be concluded that the highest prevalence of obesity is in adults, compared to children and elderly people.³

The World Health Organisation defines an overweight adult as someone that who has a body mass index (BMI) $\geq 25 \text{ kg/m}^2$, while obesity is a BMI $\geq 30 \text{ kg/m}^2$. BMI is the most-often-used body-weight calculation in both men and women.⁴ According to *The Asia-Pacific Perspective: Obesity Redefining*, an obese patient is someone who has a BMI $> 25 \text{ kg/m}^2$.⁵ The ratio of the abdominal:pelvic circumference is a simple way to distinguish lower-body obesity (pelvis) and upper-body obesity (waist and abdomen). Ratios above 0.85 for women and 0.95 for men are related to central obesity or “apple-shaped” obesity. Obesity increases risk factors for stroke, diabetes, and coronary heart disease.⁴

Acupuncture is a nonpharmacologic therapy, using fine needles inserted at specific acupuncture points. One type of acupuncture is laser acupuncture. Laser acupuncture has several advantages, such as being easy to apply, painless, and noninvasive.⁶

Laser acupuncture is a combination of acupuncture therapy with modern technology in the form of light therapy. Laser acupuncture uses lasers to stimulate acupuncture points. This form of acupuncture, at 35–40 mW of power, can produce the same effects as needle acupuncture, thus, having same therapeutic effects.

Needle stimulation can release chemical substances, such as histamine, bradykinin, and adenosine triphosphate, which cause depolarization of acupuncture points. This action is transmitted through afferent fibers to the brain, thus, in turn, activating the hypothalamus and limbic system. This stimulation can regulate the appetite center in the hypothalamus.⁷ Acupuncture also triggers release of endorphins and can suppress appetite due to decreased stress and depression. Regulation in the hypothalamus will induce release of adrenocorticotropin hormone (ACTH). Activation of ACTH can increase the adenylate cyclase enzyme in the liver, which will then activate the phosphorylation process that triggers lipolysis to reduce triglyceride levels. Acupuncture can also produce serotonin, which, in turn, produces pro-opiomelanocortin (POMC) to reduce human appetite.

The photobiomodulation effect of laser acupuncture increases local vasodilatation and improves blood circulation. This improvement reduces tissue damage and neuroinflammation, and decreases proinflammatory cytokines such as interleukin (IL) 6 and tumor necrosis factor- α (TNF- α).⁸ Leukocytes have the POMC gene, enabling them to synthesize ACTH and β -endorphins. Endogenous opioid receptors have been found in B- and T-lymphocytes. Acupuncture can regulate this system to reduce proinflammatory mediators. Acupuncture also can affect gastric motility and acid secretion.⁷

This study was conducted to determine the effects of laser acupuncture + a dietary intervention on such obesity

parameters as fasting glucose levels, insulin, waist:hip ratio, quality of life (QoL) scoring, high-density lipoprotein (HDL) levels, triglycerides, BMI, and appetite scoring in obese patients.

MATERIALS AND METHODS

Ethical Approval

This study was approved by the Ethics Committee of the Faculty of Medicine of Universitas Indonesia (FMUI), Central Jakarta, DKI Jakarta (0947/UN2.F1/ETIK/2018). All of the participants read and signed informed consents prior to the study.

Clinical Data

This study was a double blinded, randomized controlled trial that was carried out at Dr. Cipto Mangunkusumo Hospital from September 2018 to November 2018. The research was conducted at hospital's Medical Acupuncture Outpatient and Nutrition Clinic. This research was a collaborative study between the Medical Acupuncture Department of FMUI/RSCM and the RSCM Nutrition Installation, in Central Jakarta, DKI Jakarta, Indonesia.

Inclusion Criteria

The inclusion criteria for this study were women and men with ages between 18 and 60, BMIs ≥ 25.0 , and abdominal circumferences $> 80 \text{ cm}$ in women and $> 90 \text{ cm}$ in men.

Exclusion Criteria

The exclusion criteria for this study were subjects who consumed weight-loss medication (slimming tea, such as green tea, orlistat, phentermin, diethylpropion, α -cyclodextrin, and herbal medicines) in the last 25 hours, received anti-inflammatory steroid therapy in the last 16 hours, and took medication for hypercholesterolemia in the last 2 hours. Additional exclusion criteria were histories of diabetes mellitus and/or using diabetes medication, chronic digestive disorders > 3 months (diarrhea, constipation, and gastritis), abnormal kidney or liver functions, pregnancy, acute dermatitis, exacerbation of chronic skin abnormalities such as lupus erythematosus or cutaneous tuberculosis, high fever (above 39.5°C), uncontrolled epilepsy, and decompensated cardiac insufficiency. Finally, subjects who performed regular exercise at least 2–3 times per week (30–45 minutes each session) or who had contraindications to laser acupuncture were also excluded.

Sample Size

Based on the sample and dropout calculation formula, there was a total of 38 subjects, whom were divided into 2

FIG. 1. Acupuncture point CV 12 *Zhongwan*.

groups: (1) a verum laser acupuncture group ($n = 19$) and (2) a sham laser acupuncture control group ($n = 19$). Both groups received the same dietary intervention. The subjects were randomly allocated with a computer-based random table.

Intervention

Before the study started, all research subjects received an explanation of the research procedure and signed informed consent forms. The initial examinations were carried out by an assistant and included measurements of body weight, height, waist circumference, pelvic circumference, and QoL and appetite scores.

The groups received either verum laser acupuncture or sham laser acupuncture therapy for 12 sessions, 3 times per

FIG. 3. Acupuncture point SP 6 *Sanyinjiao*.

week. Dietary intervention were performed at the 1st, 5th, and 9th sessions. Blood samples were collected before the beginning of the therapy. The subjects fasted for 10–12 hours before the blood sample collection and then were examined by the clinical pathology laboratory analyzer in RSCM. Before the treatment started, each subject was put in a supine position and used laser-protection goggles. Anti-sepsis and asepsis were performed at each points before the laser acupuncture treatment.

FIG. 2. Acupuncture point ST 36 *Zusanli*.

FIG. 4. Acupuncture point ST 25 *Tianshu*.

FIG. 5. Acupuncture point ST 40 Fenglong.

The points chosen for this research were CV 12 Zhongwan (Fig. 1), bilateral ST 36 Zusanli (Fig. 2), bilateral SP 6 Sanyinjiao (Fig. 3), bilateral ST 25 Tianshu (Fig. 4), and bilateral ST 40 Fenglong (Fig. 5).⁹ In the treatment group, laser acupuncture was activated at each acupuncture point with continuous waves at 4 Joules for each point and a 50 mW-power density. In the control group (the sham acupuncture group), laser acupuncture was applied to each acupuncture point but the device was not activated. Each subject then worked with the dietician to obtain an overview of the diet and number of calories needed.

RESULTS

This study was conducted with 38 subjects who met the inclusion criteria. All subjects were randomly allocated into 2 groups, the treatment group (verum laser acupuncture + dietary intervention) and the control group (sham laser acupuncture + dietary intervention). Each group consisted of 19 subjects and, because there were no dropouts, all 38 subjects completed the study.

The preliminary data for ages showed an abnormal distribution; thus, these data were presented in median and range values. There was an extreme age values distribution in the treatment group of 26–59, while the control group's age range was 25–55. The median ages were 42 in the treatment group and 41 in the control group, corresponding with the high prevalence of obesity at the ages of 40–59.¹⁰ See Table 1.

For fasting blood-glucose level, the initial data showed that there was no significant difference between the baseline data of both groups ($P=0.358$); thus, the 2 groups were comparable. After the treatment, there was a significant difference in fasting blood-glucose level in the treatment group ($P=0.000$) and the control group ($P=0.000$). The median fasting blood glucose was 5 mg/dL in the treatment group. There was no significant difference between the 2 groups before and after treatment ($P=0.543$). See Table 2.

In insulin level, the baseline data showed that there was no significant difference between the treatment and the control groups ($P=0.50$). After treatment, there were significant differences in both groups (each were $P=0.000$ and $P=0.000$, respectively). There was no significant difference between the 2 groups before and after treatment. See Table 3.

In waist:hip ratio, the baseline data showed that there was no significant difference between the 2 groups ($P=0.630$).

TABLE 1. CHARACTERISTICS OF RESEARCH SUBJECTS

Variable	Treatment	Control	P-value
Sex			
Male	2 (10.5%)	3 (15.8%)	1,000*
Female	17 (89.5%)	16 (84.2%)	
Age (yr)	42 (26–59)	41 (25–55)	0.539**
HDL (mg/dL)	45.53	(9.605) 44.79 (10,053)	0.819***
Triglyceride level (mg/dL)	108.68 (35,951)	102.95 (31,536)	0.604***
BMI (kg/m ²)	32.5669 (4.17629)	30.28 (3.77329)	0.085***
Appetite score (mm)	67.89 (10.84)	66.32 (11,648)	0.668***
Waist:hip ratio	0.9065 (0.81–1.08)	0.9053 (0.78–0.98)	0.630**
QoL score	78.373,131	78.843,219	0.71***
Fasting insulin (mIU/mL)	12.00 (8–23)	12.00 (7–19)	0.5**
Fasting blood glucose (mg/dL)	96.896749	95.114977	0.358***

*Mann–Whitney-*U* test.

** χ^2 .

***Independent samples *t*-test.

yr, years; HDL, high-density lipoprotein; BMI, body mass index; QoL, quality of life.

TABLE 2. COMPARISON OF INITIAL AND FINAL FASTING BLOOD GLUCOSE LEVELS BETWEEN THE 2 GROUPS

Variable	Treatment	Control	P-value
Δ blood glucose	5.00 (1–12)	5.00 (4–15)	0.543**

**Mann–Whitney-U test.

After treatment, there was a significant difference in the treatment group ($P=0.000$), whereas, in the control group there was no significant difference ($P=0.080$). From these data, the current authors concluded that there was a significant difference in the decrease of waist:hip ratio in the treatment group. See Table 4.

At the end of the study, there was a significant difference in QoL score in the treatment group ($P=0.000$), whereas, in the control group, there was no significant difference ($P=0.163$). This result was in accordance with the research conducted by Hasaan et al,⁶ who assessed the appetite score and patient freshness score. There was a significant difference in the patients' appetite score and improvement in freshness score in the treatment group, compared to the control group ($P<0.05$). This result could encourage patients to improve their lifestyles. See Table 5.

In the preliminary data, there was no significant difference in HDL between the treatment and control groups ($P=0.819$). After 12 sessions, there was a significant difference in HDL levels in the treatment group ($P=0.000$) and the control group ($P=0.000$). The median level in the treatment group was 6 mg/dL. However, there was no significant difference between the treatment group and the control group ($P=0.208$). See Table 6.

In the preliminary data, there were no significant differences in triglyceride levels between the treatment and the control groups ($P=0.604$). After 12 treatments, there were significant differences in triglyceride levels in the treatment group ($P=0.000$) and the control group ($P=0.000$). The median decrease in triglyceride levels in the treatment group was 11 mg/dL. However, there was no significant difference between the treatment group and the control group ($P=0.413$). See Table 7.

In the preliminary data, there was no significant difference in BMI between the treatment and control groups ($P=0.085$). After 12 treatments, there was a significant difference in the treatment group ($P=0.033$), but there was no significant difference in the control group ($P=0.163$). The median decrease in BMI in the treatment group was

TABLE 4. COMPARISON OF INITIAL AND FINAL WAIST HIP RATIO BETWEEN THE 2 GROUPS

Variable	Treatment	Control	P-value
Δ waist:hip ratio	0.023 (0.01–0.06)	0.016 (0.0–0.02)	0.000**

**Mann–Whitney-U test.

1.4516 kg/m². In the control group, although there were no significant differences, the BMI also decreased with a median 0.0001 kg/m². See Table 8.

In the preliminary data, there was no significant difference in appetite scores between the treatment and control groups ($P=0.668$). After 12 sessions, there was a significant difference in the treatment group ($P=0.000$) and control group ($P=0.046$). The median in the treatment group was 30 mm. In addition, there were significant differences between the treatment group and the control group ($P=0.000$). See Table 9.

All results are shown in Figure 6.

DISCUSSION

This study was a double-blinded, randomized, clinical controlled trial conducted with 38 obese patients who met the inclusion criteria. The number of samples was calculated based on previous BMI data. BMI was chosen because of cost, time, and ability of the researchers.

This study was the first acupuncture study in Indonesia to assess waist:hip ratio, QoL scores, insulin and blood-glucose levels, HDL levels, triglyceride levels, BMI, and appetite scores in obese patients who were given laser acupuncture. Laser acupuncture has several advantages, such as being easy to apply, relatively fast, painless, and not invasive. In addition, laser acupuncture does not create a stabbing sensation; thus it is easy to apply, disguised as controls, for blinded, randomized clinical trials.¹¹

Selection of points in this study was based on previous studies that have proven to be effective in regulating HDL, triglyceride levels, BMI, and appetite scores. In 2015, El-Mekawy et al. proved a positive effect of laser acupuncture therapy combined with exercise training in obese patients using acupuncture points CV 4, CV 9, CV 12, ST 25, ST 36, SP 6 and ST 40. Those results showed a significant decrease in BMI, waist circumference, abdominal circumference,

TABLE 3. COMPARISON OF INITIAL AND FINAL INSULIN LEVELS BETWEEN THE 2 GROUPS

Variable	Treatment	Control	P-value
Δ insulin	3 (1–5)	3 (2–4)	1.00**

**Mann–Whitney-U test.

TABLE 5. COMPARISON OF INITIAL AND FINAL QoL SCORES BETWEEN THE 2 GROUPS

Variable	Treatment	Control	P-value
Δ QoL score	8.000(6.00–12.00)	0.00 (0–1)	0.000**

**Mann–Whitney-U test.

QoL, quality of life.

TABLE 6. COMPARISON OF INITIAL AND FINAL HDL LEVELS BETWEEN THE 2 GROUPS

Variable	Treatment	Control	P-value
Δ HDL (mg/dL)	6 (0–24)	9 (0–18)	0.208**

**Mann–Whitney-*U* test.

HDL, high-density lipoprotein.

insulin, and total cholesterol levels in that study's treatment group compared to the study's control group.¹²

The results obtained for insulin and glucose levels were in accordance with El-Mekawy et al.'s study, in which there was a significant decrease in blood-glucose levels in both the control group (16.65%) and the treatment group (30.08%).¹² In addition insulin decreased 23.51% in the control group and 32.1% in the treatment group.¹² In addition there were no significant differences in blood-glucose and insulin levels in the 2 groups after treatment.¹²

The decrease in fasting blood-glucose levels in the El-Mekawy study¹² were in accordance with Hassan et al. (2014).⁶ Hassan et al. compared the effects of therapeutic laser acupuncture, acupuncture and diet therapy along with physical activity in healthy obese women.⁶ In that study, there were no difference in fasting blood-glucose level both in the nutrition group ($P=0.625$) and the laser acupuncture group ($P=0.456$). This could be because that study's therapy sessions were conducted only once per week. In the current study, there was a significant decrease in fasting blood-glucose levels in both groups. The absence of differences in the 2 groups was likely to be influenced by the different stress levels of each person. However, the current study did not assess stress levels.

In the waist:hip ratio data, there was a significant decrease in the treatment group, compared to the control group. This is in accordance with Hassan et al.'s study,⁶ in which the waist:hip ratio of a laser acupuncture group had a significant decrease ($P=0.05$), whereas in that study's nutrition group the decrease was not significant ($P=0.06$).⁶ This is consistent with Hanon et al.'s study in which there was a significant waist:hip ratio reduction in that study's laser acupuncture group ($P=0.016$), compared to that study's diet + exercise group ($P=0.765$).¹²

The QoL score in the current study had a significant difference in the laser acupuncture group ($P=0.000$). In the

TABLE 8. COMPARISON OF INITIAL AND FINAL BMIS BETWEEN THE 2 GROUPS

Variable	Treatment	Control	P-value
Δ BMI	1.4516 (–6.83 to 2.11)	0.000 (0–42)	0.000**

**Mann–Whitney-*U* test.

BMI: body mass index

control group, there were no significant changes ($P=0.163$). This is in accordance with research by Tseng et al., who assessed appetite and patient freshness scores, and found significant changes in patients' appetite and freshness in that study's laser acupuncture group, compared to a sham laser acupuncture group ($P<0.05$).¹³

HDL, in Hassan et al.'s laser acupuncture group ($P=0.116$) and in the diet with physical activity group ($P=0.303$), showed no significant differences.⁶ This might be due to the fewer therapy sessions at 1 time/week, whereas in the current study sessions were given 3 times per week. In this study, there were no significant differences in HDL levels between the treatment and control groups. There are various factors that affect HDL such as food, exercise, and consumption of alcohol or cigarettes. Exercise could increase HDL levels up to 25%. In addition, the current study did not assess consumption of alcohol or cigarettes so it remains unknown if those variables could have been confounder factors in this study. Quitting smoking can increase levels of HDL by 10%.¹⁴

The results for triglyceride levels compared more favorably to the Hassan et al. study.⁶ In Hassan et al.'s laser acupuncture group ($P=0.127$) and diet physical activity group ($P=0.157$), there were no significant differences in triglyceride levels.⁶ In the current study, there were no significant differences in triglyceride level between the treatment and control groups. There are various factors that could have affected the triglyceride levels, such as food consumption and cigarette use as cited by Sfgate.¹⁴

The BMI results were almost the same as a study by Hu et al. that looked at the clinical effects of laser acupuncture therapy and dietary intervention in obese patients.¹⁵ The results showed a significant difference in BMI and body-weight value in that study's treatment group compared to a control group ($P<0.0001$). The results of the study were also almost the same as a study by Hung et al. that proved

TABLE 7. COMPARISON OF INITIAL AND FINAL TRIGLYCERIDE LEVELS BETWEEN THE 2 GROUPS

Variable	Treatment	Control	P-value
Δ triglycerides	11 (2–63)	16 (3–26)	0.413**

** Mann–Whitney-*U* test.

TABLE 9. COMPARISON OF INITIAL AND FINAL APPETITE SCORES BETWEEN THE 2 GROUPS

Variable	Treatment	Control	P-value
Δ appetite score	30 (10–50)	0.00 (0–10)	0.000**

**Mann–Whitney-*U* test.

FIG. 6. Comparison of initial and final scores between the 2 groups.

a positive effect of laser acupuncture therapy in obese patients. Those results showed a significant difference in BMI in a treatment group, compared to a control group ($P < 0.001$).¹⁶

The appetite score results were almost the same as the study by Tseng et al.,¹³ which proved a positive effect of laser acupuncture therapy on anthropometry and appetite scores in obese patients. Those results showed a significant difference in appetite score in a treatment group compared to a control group ($P < 0.0001$). A change in appetite score can be expected to change patients' lifestyle behaviors.¹³

Acupuncture at CV 12 *Zhongwan* and ST 36 *Zusanli* has been shown to reduce levels of TNF- α and IL-6 that, in turn, will reduce triglyceride levels because fatty acids are not converted to triglycerides via the acetyl-CoA carboxylase pathway. In addition, HDL levels increase because pro-HDL can be converted to HDL. Acupuncture at CV 12 *Zhongwan* has been shown to reduce gastric-acid secretion through sympathetic pathways.¹² Both CV 12 *Zhongwan* and ST 36 *Zusanli* points have also been shown to reduce leptin levels so that appetite will be reduced. Laser acupuncture at CV 12 *Zhongwan* has been shown to stimulate β -endorphin secretion via the μ -opioid receptors in the brain, liver, and pancreas, thereby affecting insulin secretion, and, in turn, decreasing fasting blood-glucose levels. Laser acupuncture at CV 12 *Zhongwan* has been shown to reduce levels of TNF- α and IL-6, thereby increasing the insulin-signaling pathway via IRS-1/GLUT4.¹⁷

Acupuncture at SP6 *Sanyinjiao* has been shown to reduce levels of TNF- α and IL-6 that, in turn, can reduce triglyceride levels. In addition, HDL levels increase because pro-HDL can be converted to HDL.¹⁸

Acupuncture at ST 25 *Tianshu* has been shown to reduce levels of nuclear-factor-kappa-(NF- $\kappa\beta$). This can decrease the proinflammatory cytokine DNA transcription processes, such as those involved with TNF- α and IL-6.¹⁹ In addition, ST 25

Tianshu can also trigger superoxide production, which can cause lipolysis. This mechanism has been known from observing the photo-excitatory process involved in cytochrome C oxidase in mitochondria, which releases hydrogen and calcium ions. Changes in calcium ions will stimulate cells to produce the lysosomal lipase acid enzymes that break down triglycerides stored in adipose tissue into glycerol and fatty acids. This form of triglyceride is less stable and can come out easily through a protein transporter. As result, a transitory hole will be formed in adipocyte cells so that the fat will be released into an interstitial space. The hole does not damage the cells but will efflux the cell contents (the fat) into that interstitial space, that will be removed from the body through the lymph vessels. These adipose cells then collapse and cause deflation of the body's adipose cells, which, in turn, decrease triglyceride levels and body weight.¹² Laser acupuncture at ST 25 *Tianshu* has also been shown to reduce levels of NF- $\kappa\beta$. This mechanism decreases the proinflammatory cytokines such as TNF- α and IL-6 and, as a result, increases insulin level by signaling the IRS-1/GLUT4.¹⁸

Acupuncture at ST40 *Fenglong* can increase the insulin growth factor-1, which works through the C-jun N-terminal kinase pathway. Extracellular signal-regulated kinase-1, adenosine monophosphate-activated protein kinase, and peroxisome proliferator-activated receptor (PPAR) are involved. PPAR produces Apo AII, which is an HDL-forming material; adiponectin inhibits TNF- α and IL-1 formation to increase HDL levels, decreases triglyceride levels, and increase insulin-receptor sensitivity.²⁰

No side-effects were found in this study. The limitation of this study was the variation levels of basic laboratory examinations. There were patients with laboratory values outside the normal range and patients with laboratory values that were in the normal range. A future study is expected to be carried out using a sample of obese patients with diabetes mellitus or dyslipidemia, who have not been treated with pharmacologic medications. In addition, this was a 4 week study. Further research with longer durations could produce different results.^{16,18}

CONCLUSIONS

Laser acupuncture decreases waist:hip ratio, BMI, and appetite scores, in the treatment group compared to the control group in this study. The QoL score was improved by laser acupuncture in the treatment group. It is necessary to do further research in obese patients with diabetes mellitus (blood-glucose level: 100–120 mg/dL) or dyslipidemia (HDL level: <40 mg/dL or triglyceride level $\geq$ 200 mg/dL) who have not been given medications for these conditions. A longer follow-up period will also be needed.

AUTHOR DISCLOSURE STATEMENT

No competing financial interests exist.

FUNDING INFORMATION

The authors received no financial support for this research.

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