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RESEARCH ARTICLE

Effectiveness of Acupressure at the Zusanli (ST-36) Acupoint as a Comfortable Treatment for Diabetes Mellitus: A Pilot Study in Indonesia

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Abstract
Diabetes mellitus is a dangerous disease worldwide. Indonesia has 10 million diabetic and 17.9 million prediabetic citizens. Unfortunately, less than half of these diabetic individuals are aware of their conditions and less than 1% of those receiving medical treatment achieve their healing targets. Because acupressure is believed to be an effective treatment without the use of drugs, in this study we investigated acupressure as a comfortable and effective way of treating patients with diabetes mellitus. This pilot study involved 30 participants who were split into two groups: 15 each in the experimental and the control groups. The experimental group underwent acupressure at the Zusanli (ST-36) acupoint for 30 minutes per visit for 11 weeks, whereas the control group continued their regular treatment; participants in both groups had their blood glucose randomly checked weekly. Data were analyzed using the Generalized Estimating Equation model; the result showed that the two groups were significantly different ($p = 0.331 > \alpha = 0.05$; mean difference = 99.14; Bonferroni sig. $p = 0.000 < \alpha = 0.05$) and that acupressure at ST-36 was effective in reducing blood sugar. This research showed that acupressure was an effective method for reducing blood glucose and was helpful for reducing complications due to diabetes.

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1. Introduction

Diabetes mellitus is defined as the chronic failure of the metabolism function in the human body as a result of insulin deficiency that destroys carbohydrates, proteins, and lipid metabolism and increases the risks of vascular complications marked by an increase in the blood glucose level [1,2]. According to the World Health Organization (WHO), diabetes is a chronic failure of metabolism characterized by hyperglycemia, with disorders in the metabolism of carbohydrates, lipids, and proteins [3]. This abnormality in the metabolism of carbohydrates, lipids, and proteins is caused by a lack of insulin secretion and by a reduced tissue response to insulin [1,2].

Diabetes is the main health challenge in the 21st century. According to the International Diabetes Federation, currently there are 371 million diabetic people, and another 28 million are at high risk for developing this disease. The estimated population of diabetics will increase drastically between now and the end of 2030; the number of cases is expected to double simply because of the effects of increasing life span and obesity. Many diabetics are in developing countries, with Asia and Africa having high incidence rates. The environment and genetics are thought to be the main factors accounting for the increased numbers of diabetics in different populations [4].

Diabetes is one of the most dangerous diseases in the world. It causes polyuria, polydipsia, wasting, polyphagia, glaucoma, tachycardia, hypotension, and hypertension [1–3,5]. Chronicle hyperglycemia also causes growth disorders and susceptibility to certain infections [2]. Uncontrolled diabetes causes ketoacidosis and hyperosmolar coma (hyperglycemic nonketotic). The cause of uncontrolled diabetes is not clear, but it appears to be triggered by the same factors, such as ketoacidosis, that cause dehydration [6]. Decaying limbs due to ulcers, kidney disorders, and retinopathy are among the long-term complications of diabetes mellitus [7].

In 2007, according to the WHO, Indonesia, with 10 million diabetics and 17.9 million at high risk for developing diabetes, had the fourth highest population of diabetics in the world, after the United States, China, and India. Furthermore, in Indonesia, the prevalence of diabetes mellitus increased by 135% from 1990 to 2013, putting Indonesia in seventh place worldwide, with a prevalence scale score of 11.77 [8,9]. Moreover, less than half of the diabetic populations are aware of their health. Even though the vast majority of diabetics may receive treatment, only a few—less than 1%—achieve treatment targets. Many factors can explain this failure to meet treatment targets, one of the main factors being that too few diabetics receive the proper medication (drugs or insulin). Many diabetics in Indonesia hesitate to consume drugs or to be injected with insulin. Many cannot afford the care, and some are not comfortable with medication. Some even use alternative medicine to cure their illness. These attitudes result in insufficient treatment for diabetes and failure to achieve healing targets.

Acupressure is a traditional Chinese treatment that has been used for about 5000 years. Even now, acupressure remains a popular treatment in parts of Asia, such as China, India, Japan, and Korea. Now, its use is spreading to Western countries. In traditional Chinese medicine (TCM), the normal physiological function of the human body results from a balance between harmony and opposition, the so-called Ying and Yang. In TCM, if elements such as Qi, blood, Yin, Yang, and Zang-Fu (internal organ) are not functioning correctly and not in harmony with one another, abnormalities in consciousness and even susceptibility to various diseases may occur [10,11]. Acupressure is a method of TCM and uses noninvasive finger pressure on meridians or acupoints of the body. Acupressure can release endorphins in the brain to relax muscles, reduce pain, and increase comfort [12].The Zusanli (ST 36) acupoint is a general point that is below the stomach meridian. A general point is a point that is often used in acupuncture treatment, and acupuncture treatment at this acupoint has a positive effect on the pancreas and other internal organs, not only the gastric organ.

Research on acupressure as a treatment for patients with diabetes mellitus is rarely done. Therefore, this research is very important because the objective was to find comfortable methods for effectively treating patients with diabetes mellitus. If such methods can be found, they will lead to better care, better outcome, and better quality of life. Another important goal is to decrease the prevalence of diabetes mellitus in Indonesia in particular and the world in general.

2. Materials and methods

This research was conducted as a pilot experimental study in Indonesia, an important representative country that has the fourth highest population of diabetics and the seventh highest prevalence of diabetes mellitus in the world [8]. The province of East Java was chosen for this research because it has the highest population in Indonesia (38.8 million people) [13]. Diabetics in East Java account for 6% of its population. The cities with the highest populations of diabetics in East Java are Surabaya, Malang, Sidoarjo, and Gresik. Surabaya has the highest population and reports 14,377 new cases per year; Malang has the second highest population and reports 7534 cases per year [14,15].

Data on the diabetics were collected from Fit4global Society Care, an institution in Indonesia that has been concerned with diabetes mellitus since 2007. Fit4global participants from Surabaya and Malang were chosen in this research. The sampling method appropriate for this study was *nonprobability sampling*, with *purposive sampling* [16]. For this method, the minimum total sample size for an experimental study is 15 participants per group [17,18], and the suggested minimum sample size is 30, with 15 participants per group. Thus, in this study, the number of participants or the sample size was set at 30 (n), consisting of 15 participants in the experimental group and 15 in the control group.

Potential participants were visited at their homes to determine if they satisfied the criteria for selection to participate in this research. From the potential participants, 30 who satisfied the requirements as shown in the study flow in Figure 1 were selected. This research used an experimental analytic epidemiology research design as a

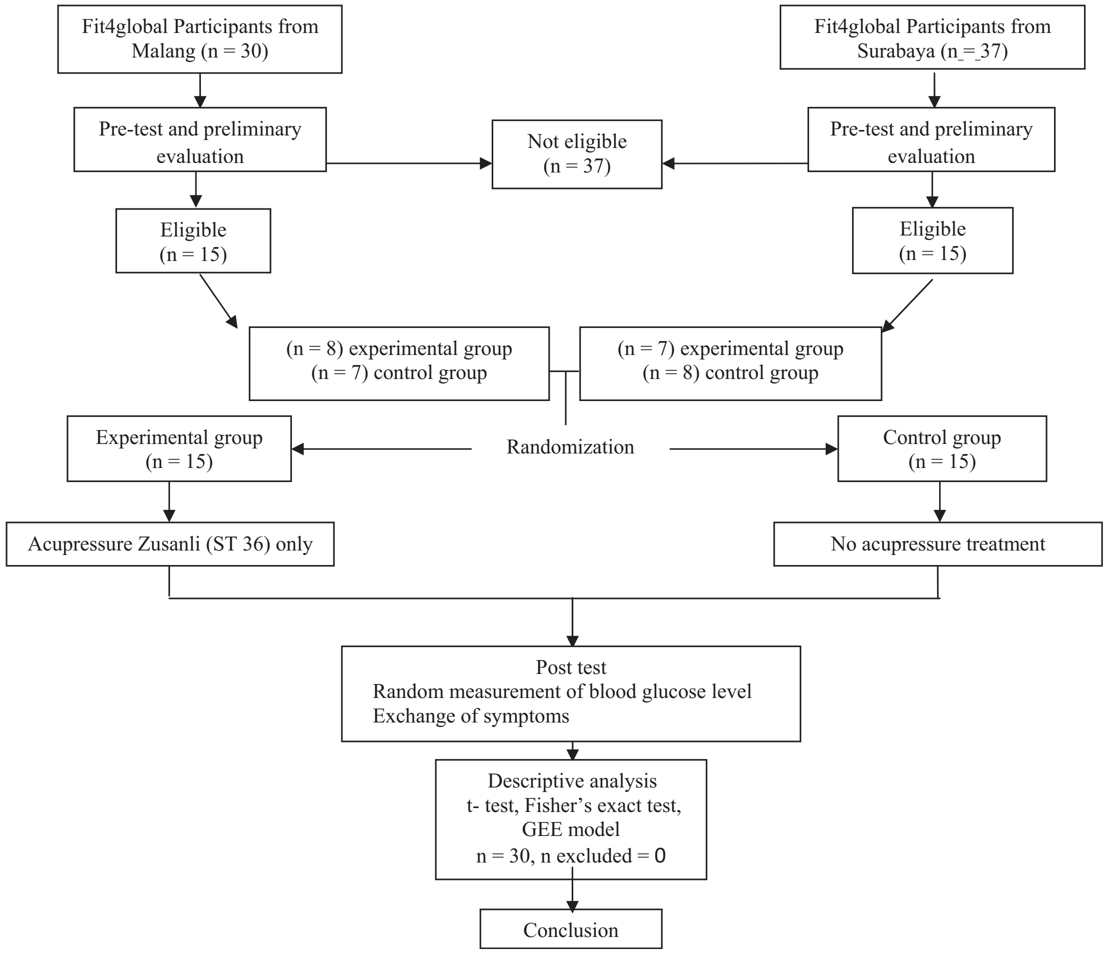

Figure 1 Research design and study flow. GEE = Generalized Estimating Equation.

randomized controlled trial. Thus, the 30 selected participants were randomly divided into two groups, the experimental and the control groups, with 15 participants in each group by using the Statistical Package for the Social Sciences (SPSS) so that participants were divided evenly and homogeneously. The experimental group received acupressure therapy at the Zusanli (ST-36) acupoint and had not received treatment prior to this research (see Table 1). Acupressure was done by a researcher who was an expert in acupressure and had been in practice for 17 years. The participants in the control group continued to receive their current treatments during the research and were not given acupressure therapy. The participants and their families freely approved the use of data related to them in this study. This study was approved by Fit4global Society Care.

Tests were given prior to (pretests) and after (posttests) this research to determine the blood glucose levels of the participants and their general health conditions, as well as weekly after the procedure. The single-blind method was used in this research so that participants did not know if they were in the experimental group or the control group, and they could interact and communicate well with the researcher. Data were recorded, and the blood glucose levels measured during the study were known by both the participants and the researchers. The experiments were conducted in the participants' homes in Surabaya and Malang from January 2015 to April 2015. Participants in the control group followed their normal therapy, whereas participants in the experimental group received acupressure at Zusanli (ST 36) by using the thumb with pressure and scrubbing [19,20]. The Zusanli acupoint (Figure 2) is also known as the stomach 36 or ST36 acupoint and lies on the Yang Ming foot hull meridian. Treatment at this point is very effective, specifically for gastric organs. The Zusanli acupoint is located 3 cm below the patella and one finger lateral to the tibial crest [19,21]. Acupressure was done from Week 1 to Week 9 for 30 minutes every treatment session. The frequency of therapy given to each participant varied every week—1, 2, or 3 times a week—depending on the participants' conditions and their level of suffering. The more acute the suffering, the higher the therapy frequency used. When the effects of the illness were reduced, the frequency of therapy was reduced.

Blood glucose levels (mg/dL) were randomly checked every week during the study using a glucose meter (Easy-Touch GCU model: ET-301F sensor by Chiuan Rwey Enterprise Co. Ltd., Taoyuan, Taiwan). Blood glucose data were taken directly by the researchers after treatment and

Table 1 Demographic information of experimental and control groups ($n = 30$).

Variable	Experimental group ($n = 15$) n (%) or mean (SD)	Control group ($n = 15$) n (%) or mean (SD)	t or (χ^2)*	p
Sex†			$\chi^2 = 0.0$	1.00
Men	8 (53.3)	8 (53.3)		
Women	7 (46.7)	7 (46.7)		
Age (y)‡	50.13 (15.79)	51.33 (11.70)	t = −0.236	0.815
Previous treatments†				
Oral drugs			$\chi^2 = 4.61$	0.1
Yes	11 (73.3)	15 (100.0)		
No	4 (26.7)	—		
Used insulin			$\chi^2 = 0.54$	0.71
Yes	7 (46.7)	9 (60.0)		
No	8 (53.3)	6 (40.0)		
Used traditional/alternative medicine			$\chi^2 = 4.61$	0.1
Yes	11 (46.7)	15 (100.0)		
No	4 (26.7)	—		
Body mass index (kg/m^2)‡			$\chi^2 = 0.009$	1.00
Men	23.80 (2.19)	25.51 (5.49)		
Women	24.40 (4. 94)	26.60 (5.12)		
Years suffering from diabetes‡	8.80 (4.54)	7.8 (4.19)	$t = 0.627$	0.536
Knowledge about Acupressure†			$\chi^2 = 0.24$	1.00
Yes	2 (13.3)	3 (20.0)		
No	13 (86.7)	12 (80.0)		
Exercise†			$\chi^2 = 0.54$	0.71
Yes	6 (40.0)	8 (53.3)		
No	9 (60.0)	7 (46.7)		
Random blood glucose level (pre)‡	351.53 (154.704)	261.67 (72.017)	$t = 2.040$	0.05

SD = standard deviation.
* t Test or Fisher's exact test.
† Number of data and percentage.
‡ Average and standard deviation.

immediately recorded. A questionnaire was completed by interviewing the participants. The questionnaire contained preliminary information on the participants, demographic data, the duration of the disease, and the kinds of treatments they had received prior to this research. The questionnaire was completed twice, once at the beginning of the study and once at the end of the study. The scoring scale used on the questionnaire was the Guttman scale. The collected data were processed and analyzed for comparisons between the experimental and the control groups, as shown in Table 1.

Data were analyzed using SPSS with the characteristics of large-scale continuous sample data and included n observations, the mean, and the standard deviation. The analytical methods used in this research were descriptive analyses, the t test, Fisher's exact test (χ^2), and the Generalized Estimating Equation (GEE) model. The t test and Fisher's exact test were used to test the homogeneity of the initial data on the participants, to test the significance of differences in the random blood glucose levels between the experimental and the control groups, and to measure the significance of the differences in complications prior to and after the treatments. The GEE was used to analyze the data correlation in repeated measurements of the blood glucose levels. All p values were set with α less than 0.05.

3. Results

The data were collected from 67 candidates for this study at Fit4global Society Care. Thirty-seven candidates did not meet the requirements for inclusion in the study (see Figure 1). The 30 candidates who met the requirements to qualify as participants in this study were divided randomly into two groups. Seven participants from Malang and eight from Surabaya were included in the experimental group, and eight participants from Malang and seven from Surabaya were included in the control group.

The average age of the experimental group was 50.13 ± 15.79 years, whereas that of the control group was 51.33 ± 11.70 years. The numbers of men and women in the experimental and the control groups were the same, eight men (53.3%) and seven women (46.7%) in each group. The body mass index values in the experimental and control groups were not significantly different ($\chi^2 = 0.009$, $p = 1.00$). The participants in the experimental group had, on average, suffered longer from diabetes mellitus (8.80 ± 4.54 years) than the participants in the control group (7.80 ± 4.19 years). Participants in the experimental group (86.7%) and participants in the control group (80.0%) generally had little or no knowledge about acupressure prior to this research. None of the participants in either group had a sufficient amount of exercise ($\chi^2 = 0.54$,

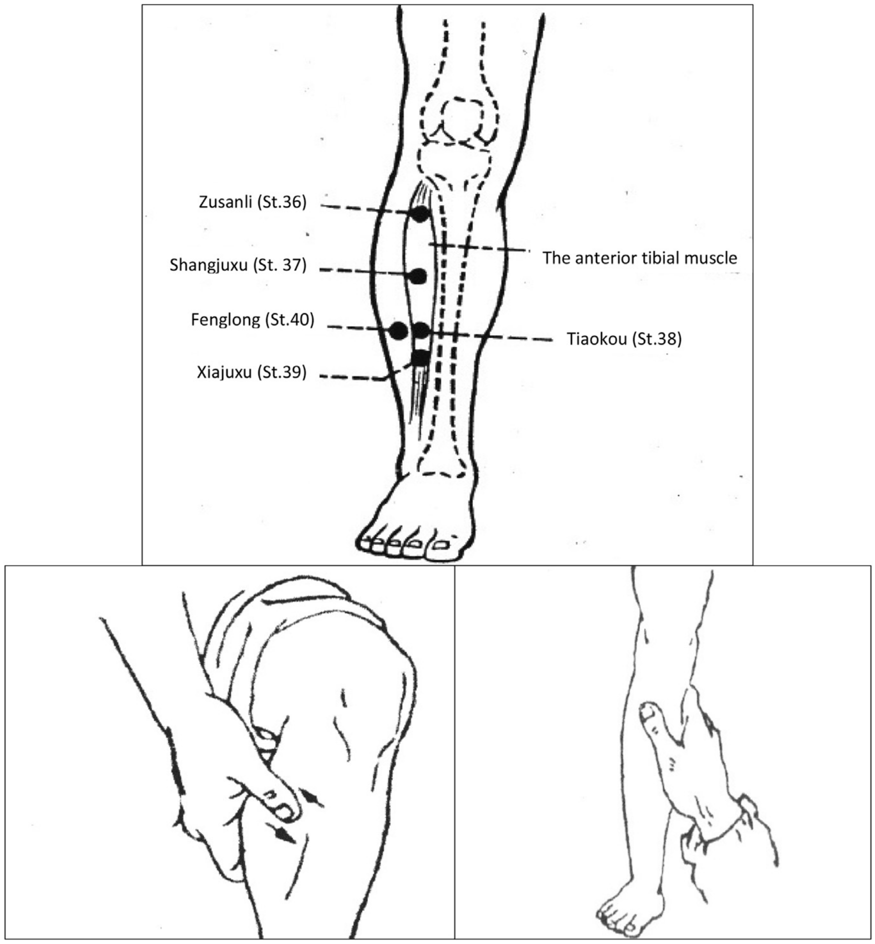

Figure 2 Sketch of the Zusanli (ST 36) acupoint. *Note*. From *Finger Acupressure*, by P. Chan, 1995, Ballantine Books, New York and "Relaxation acupressure reduces persistent cancer-related fatigue," by S.M. Zick, S. Alrawi, G. Merel, B. Burris, A. Sen, A. Litzinger, et al., 2011, *Evid Based Compl Altern Med*, 8, p. 1–10.

$p = 0.71$). Statistically, the preliminary data for the two groups did not differ significantly. The most common disease symptoms were similar in both groups. No statistical differences in the diagnoses of complications were noted between the groups. The average random blood glucose levels on the pretest were 351.53 ± 154.704 mg/dL in the experimental group and 261.67 ± 72.017 mg/dL in the control group, showing that the average value in the experimental group was higher than that in the control group, but the difference was not significant ($t = 2.040$, $p = 0.05$).

In the experimental group, the average glucose level at the beginning of Week 1 was 351.53 ± 154.704 mg/dL, then declined from Week 2 to Week 9, and reached 113.87 ± 37.840 mg/dL at Week 10 and 111.07 ± 6.628 mg/dL at Week 11 (normal). By contrast, the opposite was seen in the control group; the average blood glucose level fluctuated, but did not decrease significantly. In Week 1, the average blood glucose level was 261.67 ± 72.017 mg/dL; it then decreased in Week 2, but from Week 3 to Week 5, it increased. In Week 6, it decreased, but in Week 7 and Week 8, it increased again. In Week 9, it was down a bit, in Week 10 it was up again, and in Week 11 it was down again. The average reduction in the random blood glucose level in the experimental group was 240.47 ± 155.211 mg/dL, whereas that in the control group was very small at 35.80 ± 82.82 mg/dL (see Table 2).

The effect of acupressure at the Zusanli acupoint was also analyzed using the GEE model. The GEE is given by

$$y = 226.676 + 23.81 \text{ Group} - 2.178 \text{ Week} + 0.219 \text{ Pre} - 20.491 \text{ Group} \times \text{Week}. \quad (1)$$

The analysis showed a correlation between the experimental and control groups ($p = 0.331 > \alpha = 0.05$; mean difference $= 99.14$; Bonferroni sig. $p = 0.000 < 0.05$), with Group coefficient $= 23.81$ as shown in Equation 1. The GEE analysis also showed a correlation between the group and the visit ($p = 0.0001 < \alpha = 0.05$) (Table 3). The symptoms of diabetes mellitus in the participants of the experimental group were significantly different after acupressure at Zusanli (ST 36); in general, they felt fresh and were not easily tired, and urination was less frequent. Furthermore, in some participants, paralysis had been cured and they were able to walk again; foot wounds had healed; the black marks on some of their legs had disappeared; the myopic

Table 2 Changes in randomly determined blood glucose levels in experimental and control groups (mg/dL) ($n = 30$).

	Experimental group ($n = 15$)			Control group ($n = 15$)		
	Min	Max	Mean ± SD	Min	Max	Mean ± SD
Week 1 (pre)	132	670	351.53 ± 154.704	157	365	261.67 ± 72.017
Week 2	153	390	283.73 ± 79.394	154	450	256.27 ± 83.505
Week 3	109	380	238.40 ± 91.359	127	365	266.40 ± 71.468
Week 4	140	340	229.53 ± 67.446	148	500	310.47 ± 88.465
Week 5	115	295	181.93 ± 55.600	183	350	321.73 ± 109.645
Week 6	108	270	168.67 ± 50.941	205	340	267.40 ± 39.302
Week 7	80	251	145.60 ± 47.420	163	432	272.40 ± 73.807
Week 8	103	220	133.13 ± 37.840	167	400	278.00 ± 57.359
Week 9	100	180	121.40 ± 23.216	159	350	253.53 ± 56.245
Week 10	90	135	113.87 ± 37.840	190	450	287.40 ± 74.663
Week 11 (post)	97	126	111.07 ± 6.628	192	283	225.87 ± 29.189
Reduction average	20	566	240.47 ± 155.211	−69	158	35.80 ± 82.82

Weeks 1–9 were the treatment period; Weeks 10 and 11 were the posttreatment period.
SD = standard deviation.

Table 3 Generalized Estimating Equation model for blood glucose levels ($n = 30$).

Variable/test	Estimate	Standard Error	95% WCI	p
Intercept	226.676	10.755	205.68 to 247.84	<0.0001
Group (Experimental × Control)*	23.810	24.482	−24.174 to 71.79	0.331
Week	−2.178	1.3844	−4.891 to 0.536	0.116
Pre (baseline)	0.219	0.0249	0.170 to 0.268	<0.0001
Group × Week†	−20.491	3.5208	−27.392 to −13.591	<0.0001

WCI = Wald confidence interval.
* The correlation between the experimental and the control groups.
† Correlation between the group and the week (visit).

eyes of some participants had become clear; one man even recovered from heart disease. In general, the participants in the experimental group felt comfortable with acupressure.

4. Discussion

In this study, the random blood glucose levels of participants in the experimental group were significantly better than those of participants in the control group both during and after intervention; the results were very satisfactory. According to our analysis using the GEE models, there is a correlation between the experimental and control groups ($p = 0.331 > \alpha = 0.05$; mean difference = 99.14; Bonferroni sig. $p = 0.000 < \alpha = 0.05$); this correlation means that the experimental and control groups in this research were significantly different. Another result was an observed correlation between the experimental group and the week or the number of visits ($p = 0.0001 < \alpha = 0.05$), which means that the week or the number of visits had an effect on the blood glucose levels of participants in the experimental group. By using the GEE model, we were able to predict properly the blood glucose levels after intervention, as shown by y in Equation 1.

The decrease in the average random blood glucose level in the experimental group was significantly different from that in the control group, as shown by mean difference = 99.14, with Bonferroni significance $p = 0.000 < \alpha = 0.05$ (Table 4). Given that the effectiveness of acupressure in this study was not limited to a specific type of diabetes and that the participants involved in the study were not required to undergo a special diet and/or regular exercise, all types of diabetes were effectively treated, and the results were in accordance with the previous assumption that acupressure, with proper diet and regular exercise, can prevent complications and improve the condition of hyperlipidemia neuropathy in patients with type 2 diabetes [22]. This study demonstrated that acupressure at Zusanli (ST 36) was an effective and comfortable way of treating patients with diabetes. Acupressure stimulates the release of neurotransmitters that carry signals along the nerves or through glands that then activate the hypothalamus–pituitary–adrenal axis to regulate the function of the endocrine glands.

In this research, the symptoms of the participants in the experimental group were effectively eliminated, and the participants felt comfortable with this treatment. As a result, they no longer depend on drugs and live normal lives. Acupressure can cause the body to relax and is easy, safe, efficient, and nonpharmacological [23]. The WHO recognizes acupressure as a treatment to activate neurons in the nervous system, where it stimulates the endocrine glands and can turn on problematic organs [24]. In the same

Table 4 Pairwise comparisons.

(I) Group	(J) Group	Mean difference (I−J)	Std. Error	*df*	Bonferroni sig.	95% Wald confidence interval for difference	
						Lower	Upper
Experimental	Control	−99.14*	8.177	1	0.000	−115.16	−83.11
Control	Experimental	99.14*	8.177	1	0.000	83.11	115.16

Pairwise comparisons of estimated marginal means based on the original scale of the dependent variable, the blood glucose level.
* The mean difference is significant at the 0.05 level.

way, acupressure also helps to normalize blood glucose levels naturally without side effects and can even improve physical and mental health [25]. As a result of this research, we can conclude that acupressure, as nonpharmacological therapy, is able to treat patients with insulin sensitivity and increase hypoglycemic activity; thus, its use may reduce the prevalence of diabetes. In addition, acupressure in a nonpharmacological or natural way was able to provide a possible cure for diabetes mellitus because the participants in the experimental group were able to achieve the normal blood glucose levels that they expected to reach. The average random blood glucose levels were stabilized after Weeks 10 and 11, a very satisfactory result.

This study focused on only one acupoint. Further research using other acupoints or using ST (36) in combination with one or more other acupoints or using other methods would be very important for accelerating the process of healing for patients with diabetes mellitus. Clinical studies with larger sample sizes should also be done in the future to verify and expand on the findings in this research. Finally, future investigations on treatment complications caused by diabetes mellitus should produce very important results.

In conclusion, acupressure at the Zusanli (ST 36) acupoint can lower blood glucose levels significantly. In addition, the result of the GEE model was $y = 226\,676 + 23.81$ group $-$ 2178 pre $-$ 20.491 group $\times$ week $+$ 0.219 week, showing a correlation between the experimental group and the control group ($p = 0.331 > \alpha = 0.05$; mean difference $= 99.14$; Bonferroni sig. $p = 0.000 < \alpha = 0.05$), making the conclusions of this research acceptable. This study also showed that acupressure can reduce and even cure the symptoms of diabetes. The participants also felt comfortable with acupressure as an alternative treatment for diabetes mellitus.

Disclosure statement

The authors have no conflicts of interest or financial interests related to the material in this manuscript to declare.

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