

Research Article

Auricular Acupressure to Improve Menstrual Pain and Menstrual Distress and Heart Rate Variability for Primary Dysmenorrhea in Youth with Stress

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Background. Dysmenorrhea and accompanying symptoms can have a negative impact on academic achievement, physical activity and functioning, and quality of life. Unfortunately, stress increases the sensitivity and severity of pain, activating sympathetic responses while inhibiting parasympathetic responses. **Objective.** This study used objective, physiological measurements to evaluate the effects of auricular acupressure on menstrual pain and menstrual distress in young college students with primary dysmenorrhea across two menstrual cycles. The aim was to determine if significant differences could be detected between the intervention and follow-up phases after controlling life stress. **Design.** A one-group experimental research design was used, and repeated measurements and followups were done. Thirty-two women completed questionnaires and physiological parameters were measured. **Results.** Significant differences between the intervention and follow-up phases were found for high frequency (HF) and blood pressure on day 1 and no significant differences in menstrual pain and menstrual distress, heart rate variability, low frequency (LF), LF/HF ratio, or heart rate. **Conclusion.** Auricular acupressure effectively increases parasympathetic activity to maintain autonomic function homeostasis in young women with primary dysmenorrhea and may have a value in alleviating menstrual pain and menstrual distress in a high-stress life. Future studies should consider stress, stimulus dose of auricular acupressure, severity of menstrual pain, and a longitudinal research design.

1. Introduction

The prevalence of dysmenorrhea in adolescents and young women ranges between 40% and 90% and varies with age, country of residence, and population density [1–5]. Dysmenorrhea refers to cramp-like, dull, and throbbing pain that emanates from the lower abdomen [6, 7], often accompanied by nausea, vomiting, headaches, backaches, weakness, diarrhea, sleeplessness, or nervousness [8]. Such debilitating symptoms limit daily activity [9] leading to short-term school absenteeism and have negative consequences on health-related quality of life [9, 10]. In addition, dysmenorrhea is associated with decreased exercise performance

[11], increased pain sensitivity [12], and changes in gray-matter volume [13] and brain metabolism [14]. Alleviating menstrual pain and menstrual distress is a critical women's health concern. Dysmenorrhea is significantly and positively associated to perceived levels of stress, occurring with an odds ratio of 2.4 in high-stress female populations compared to low-stress populations [15]. Stress refers to a state of threatened homeostasis and ubiquitous presence [16]. It tends to increase a person's sensitivity to pain although there is wide variability among individuals [17]. Dysmenorrhea has been found by many to be associated with psychological stress [18, 19], as well as stress from daily life [20] and work [21, 22].

Stress and pain both activate the sympathetic nervous system to release epinephrine and norepinephrine, which increase heart rate (HR), cardiac contractility, vascular smooth muscle contraction, and blood pressure (BP) [16, 23]. At the same time, stress and pain reduce activation of the parasympathetic nervous system (PNS) responses [24, 25]. Heart rate variability (HRV) is a convenient noninvasive method for measuring overall autonomic nervous system activity, based on interactions between the sympathetic and parasympathetic nervous systems [26]. HRV measurements incorporate a low-frequency (LF) component that represents sympathetic nerve activity, and a high-frequency (HF) component reflecting vagal activity. The LF/HF ratio mirrors the sympathovagal balance and reflects modulations in sympathetic activity [27]. HR and BP must also be considered as elements of the sympathetic reaction [16]. Autonomic fluctuations in response to pain usually lead to changes in cardiovascular parameters, such as increases in BP [28, 29] and HR [24, 30] and a decrease in HRV [24, 30]. Women experiencing primary dysmenorrhea possess low parasympathetic nerve activity throughout their menstrual cycle [31], but such activity increases after acupuncture stimulation [32]. In healthy women, however, there is no association between pain perception and HR [33]. Investigating the relationship between pain and autonomic regulation in women with dysmenorrhea is the focus of this study.

Approximately 67% of young females with primary dysmenorrhea take analgesic drugs [34], which can only alleviate pain temporarily [35]. Nonsteroidal anti-inflammatory drugs (NSAIDs) and oral contraceptives pills (OCPs) are prescribed for the relief of menstrual pain, and a systematic review study concluded that such treatments are effective [7]; however, it was noted that NSAIDs and OCPs can induce or exacerbate preexisting hypertension [36]. NSAIDs are associated with a variety of adverse effects including gastrointestinal disorders, nephrotoxic, and hepatotoxic effects, hematologic abnormalities, and fluid retention [37] and fail to alleviate menstrual pain in 20% to 25% of women [38]. OCPs also have a host of side effects including nausea, vomiting, headaches, breast tenderness, acne, weight gain, and depression [39]. Therefore, the search for an alternative yet effective nonpharmacological interventions to relieve pain in dysmenorrhea is necessary. The result of a recent systematic review and meta-analysis indicates that acupoint stimulation is an effective intervention for primary dysmenorrhea [40]. Auricular acupressure is a noninvasive acupoint stimulation that transmits signals to the brain and to specific organs to modulate and harmonize physiological function [41]. The positive effects of auricular acupressure to alleviate menstrual pain and menstrual distress have been studied and reported [42–46], although some of these studies lacked methodological rigor [40] or failed to measure physiological indicators [45].

2. Purpose Statements

In this study, physiological parameters were measured across two menstrual cycles in young college students with primary dysmenorrhea in order to objectively evaluate the effects of

auricular acupressure. We hypothesized that after controlling for life stress, significant differences would be identified for menstrual pain, menstrual distress, and HRV physiological parameters between the intervention and follow-up periods.

3. Materials and Methods

3.1. Research Design and Participants. A single-group experimental research design was used, and repeated measures were done in the intervention and follow-up phases. A convenient sample of young college students with primary dysmenorrhea was recruited from a college in northern Taiwan. All participants were given auricular acupressure to relieve their menstrual pain and menstrual distress for a certain period. The inclusion criteria were (1) 18 to 25 years of age, (2) menstrual-cycle duration between 25 and 40 days, (3) body mass index between 18.5 and 24.9 kg/m², and (4) pain score 3. Women meeting the following criteria were excluded: (1) diagnosis of pelvic disease, gynecological disease or surgery, or secondary dysmenorrhea, (2) chronic disease, such as diabetes, renal disease, or cardiovascular disease, (3) serious arrhythmia or pacemaker user, (4) habitual smoking or consumption of stimulant beverages such as tea, coffee, or alcohol, and (5) swelling, infections, and ulcers in both ears. Sample size was estimated using G Power software and was based on the study of Yeh et al. [45], which indicated that auricular acupressure was effective in relieving menstrual pain, providing an average (\pm standard deviation) improvement of 5.14 ± 2.32 points in the visual analog pain score. An estimated sample size of 32 would be required to demonstrate significant at the 5% probability level with 80% power. Figure 1 shows the flowchart of research design and participants of this study. Menstrual pain, menstrual distress, and HRV physiological parameters were measured.

3.2. Intervention. Based on a literature review of auricular acupressure for treating dysmenorrhea, six common auricular acupoints were used: *internal genitals*, *endocrine*, *shenmen*, *sympathesis*, *liver*, and *kidney*. The *internal genitals* acupoint was selected to dredge the meridian and normalize circulation, eliminate stasis, and alleviate pain. The *endocrine* acupoint was targeted to harmonize physical function, regulate menstruation, and improve menstrual distress. The *shenmen* acupoint was used to reduce pain and provide tranquility [47], while the *sympathesis* acupoint was to normalize autonomic nervous system and vasomotor functions, relieve muscle spasm, and enhance the analgesic effect [47, 48]. The *liver* acupoint was stimulated to disperse stagnated liver qi for relieving stagnation and to regulate the flow of qi for alleviating pain, and the *kidney* acupoint was stimulated to coordinate Chong and conception vessels, invigorate kidney qi, and active qi and blood for the relief of pain [48]. Cowherb seeds with adhesive patches were embedded on the specific acupoints two to three days before menstruation, and the application of pressure was initiated at the onset of menstrual pain. All participants were instructed to press each acupoint for 1 minute, 4 times per day until they achieved relief of menstrual pain. They were also informed

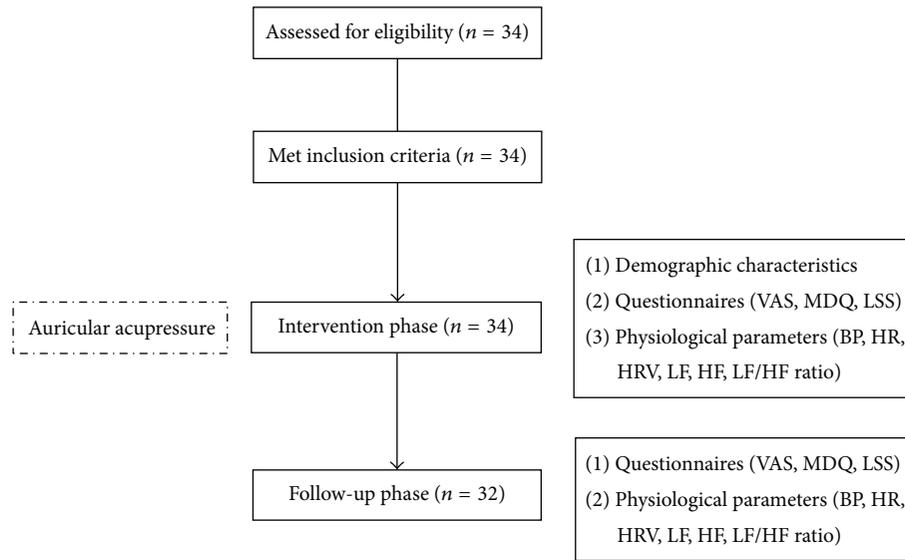


FIGURE 1: Study flowchart.

that they may experience various sensations while applying pressure: numbness, swelling, mild pain, or warmth. The adhesive patch and Cowherb seed were removed accordingly only if pain had been relieved for 48 hours.

3.3. Measures. Menstrual pain was evaluated using a 100 mm horizontal visual analogue scale (VAS) where 0 represented no pain and 100 indicated unbearable pain. Participants were instructed to indicate a point on the scale corresponding to the pain intensity. The distance from the left end to the selected point was measured to calculate the pain score in millimeters. Higher scores represent higher intensity of menstrual pain. Menstrual distress was measured using the modified 16-item Menstrual Distress Questionnaire (MDQ) that assesses menstruation related symptoms (pain, water retention, and autonomic reactions) during the premenstrual and menstrual periods [49]. Each item was scored from 1 (no symptoms) to 4 (severe symptoms), with higher scores reflecting higher severity of distress. Cronbach's alpha for the internal consistency reliability was 0.83 in the earlier study [45] and 0.80 in this study.

HRV was measured using an ANSWatch wrist monitor (Taiwan Scientific Co., Taipei, Taiwan). This monitor uses multiple piezoelectrical sensors in the cuff to measure blood pressure waveforms in the radial artery. HRV, LF, HF, and LF/HF ratio were analyzed based on the international standard [27]. The accuracy of ANS monitor was represented by the correlation between HRV parameters and EKG [50]. HRV measurements were taken between the hours of 8 pm and 10 pm, and participants were instructed to refrain from eating, drinking stimulant beverages (such as tea, coffee, and alcohol), smoking cigarettes, and exercising 2 hours prior to the measurements. Participants were first subjected to rest quietly for 10 minutes in a sitting posture; and were then assisted to wear the ANS monitor on the left wrist, instructed to close eyes, to relax and remain quiet, and to not move

for 7 minutes while waveforms were being recorded. HR and BP were measured at the same time. Data were downloaded to a notebook using the ANS Watch Manager Pro software.

The Chinese version of the Life Stress Scale (LSS) [51] was used to measure life stress over the preceding month. The LSS consisted of 29 items categorized into six subscales: including academic stress, family stress, interpersonal stress, emotional stress, employment stress, and self-cognition stress. Each item was scored from 0 (no stress) to 4 (extremely stressful). Higher scores indicated a higher level of life stress. Cronbach's alpha was 0.92 from a previous study [51] and 0.92 in this study.

3.4. Procedures and Data Analysis. The study protocol and design were reviewed and approved by the Chang Gung Medical Foundation Institutional Review Board (reference number: 100-2728A3). Verbal and written informed consent were obtained from all participants after informing them of the study design, intervention, data collection, and the rights of the participants. They were made aware that all data remained confidential at all times and that they were free to withdraw at any time during the study without affecting their academic grades. Interventions and data collection were performed by the researcher and trained research assistants. Menstrual pain and HRV parameters were measured repeatedly during the intervention phase and the follow-up phase; while menstrual distress and life stress levels were measured once at the end of menstruation during the intervention phase and follow-up phase. Day 1 indicated the day of greatest menstrual pain during the menstrual cycle. Adverse effects of the intervention were also recorded. Data were analyzed using IBM SPSS 20.0 for Windows. Descriptive statistics was used to analyze demographics. A paired *t*-test was used to test for differences between the two phases in VAS, MDQ, physiological parameters, and LSS. $P < 0.05$ was considered statistically significant.

TABLE 1: Participants' demographic characteristics.

Characteristics	Mean \pm SD	<i>n</i> (%)
Age (years)	20.78 \pm 1.53	
Age at menarche (years)	11.94 \pm 0.91	
Menstrual cycle (days)	30.97 \pm 3.28	
Menses duration (days)	6.28 \pm 1.37	
Past pain intensity	7.75 \pm 1.53	
Menstrual regularity		
Yes		25 (78.1%)
No		7 (21.9%)
Initial onset of menstrual pain		
Menarche		3 (9.4%)
<1 year after menarche		14 (43.8%)
1-2 years after menarche		9 (28.1%)
Others		6 (18.8%)
Time of dysmenorrhea		
Day before menses		8 (25%)
First 2 days in menses		23 (71.9%)
Others		1 (3.1%)

4. Results

Thirty-four women were recruited for the study, two of whom later withdrew due to personal reasons. Thus, 32 women completed the study, and the attrition rate was 5.88%. Table 1 shows the demographic characteristics of the participants. The mean age for women in the study was 20.78 \pm 1.53 years, and the mean age at menarche was 11.94 \pm 0.91 years. The average menstrual cycle length was 30.97 \pm 3.28 days, and the mean menses duration was 6.28 \pm 1.37 days. Most participants had regular menstruation and first experienced menstrual pain less than two years after menarche. Menstrual pain occurred in the first two days of menses. Past pain intensity was 7.75 \pm 1.53.

Table 2 shows the comparison of MDQ and LSS between the intervention phase and follow-up phase. The MDQ was slightly higher in the intervention phase, but the difference was not statistically significant ($P = 0.26$). LSS was found to be significantly higher during the intervention phase compared to the follow-up phase ($P = 0.001$). Figure 2 shows the comparison of VAS and physiological parameters on days 1–3 of the two phases. Significant differences between the two phases were found on day 1 for HF ($P = 0.01$), systolic BP ($P = 0.005$), and diastolic BP ($P = 0.001$), but not for menstrual pain ($P = 0.75$), HRV ($P = 0.70$), LF ($P = 0.40$), LF/HF ratio ($P = 0.12$), and HR ($P = 0.89$). No significant differences were found for VAS or other parameters on days 2 and 3 ($P > 0.05$).

5. Discussion

The average age of menarche for the participants in this study was 12 years. Most participants first experienced menstrual pain within two years of menarche, and the menstrual pain continued for nearly 7 to 8 years. Menstrual pain

TABLE 2: Menstrual distress and life stress in the intervention and follow-up phases.

Variables	Intervention Mean \pm SD	Follow-up Mean \pm SD	Paired <i>t</i> -test
Menstrual distress	29.47 \pm 5.95	28.31 \pm 5.95	1.15
Life stress	31.97 \pm 16.32	28.53 \pm 16.38	3.75**

** $P < 0.01$.

of the participants in this study persisted for 2 to 3 days during the menstrual cycle, which is consistent with other studies [37, 52]. Menstrual pain was similar during the first three days of the cycle in both the intervention phase and follow-up phase, whether auricular acupressure was used or not. For both the intervention and follow-up phases, menstrual pain level was at 5.74, 4.07, and 2.22 on days 1, 2, and 3, respectively. Without considering stress, this finding is not consistent with the effects of auricular acupressure for improving dysmenorrhea reported in other studies [42, 45, 46]. Indeed, life stress impacts menstrual pain in the intervention phase. With life stress influences [17], menstrual pain would be more serious if auricular acupressure was not given. Therefore, the effect of auricular acupressure on reducing menstrual pain was insignificant. Comparing to the results from follow-up phase with low life stress, this study supports that the effect of auricular acupressure is reduction of menstrual pain.

In addition, participants have an obviously lowered pain perception in the intervention (5.66) phase and follow-up (5.81) phase compared to the average pain intensity (7.75) from the previous month prior to intervention. This indicates that auricular acupressure may improve menstrual pain during the intervention phase and that the effect may persist through the follow-up phase. On the other hand, the effects of auricular stimulation for acute pain were immediate rather than long term while comparing standard medical care alone or in combination with auricular acupuncture [53]. It should be noted that no obvious reduction of menstrual pain was found between the intervention and follow-up phases in this study, and it seems that the stimulant dose of auricular acupressure is insufficient to alleviate menstrual pain. This study suggests that the protocol for acupressure application can be considered multiple times per day that may improve the overall duration of the effect. Further studies should also increase stimulus dose, including acupressure frequency, duration, and intensity and examine a prolonged course of intervention for achieving a long-term effect.

This study found that menstrual distress from menstrual-related symptoms was due primarily to pain, water retention, and autonomic reactions. Although auricular acupressure was provided, menstrual distress during the intervention phase was similar to the follow-up phase; making the result inconsistent with previous studies [42, 45, 46]. As mentioned previously, the participants would have had more pain and autonomic responses during the high life stress of the intervention phase, which should also be observed as a factor affecting the results of menstrual distress. Thus, there were no obvious effects of auricular acupressure in reducing

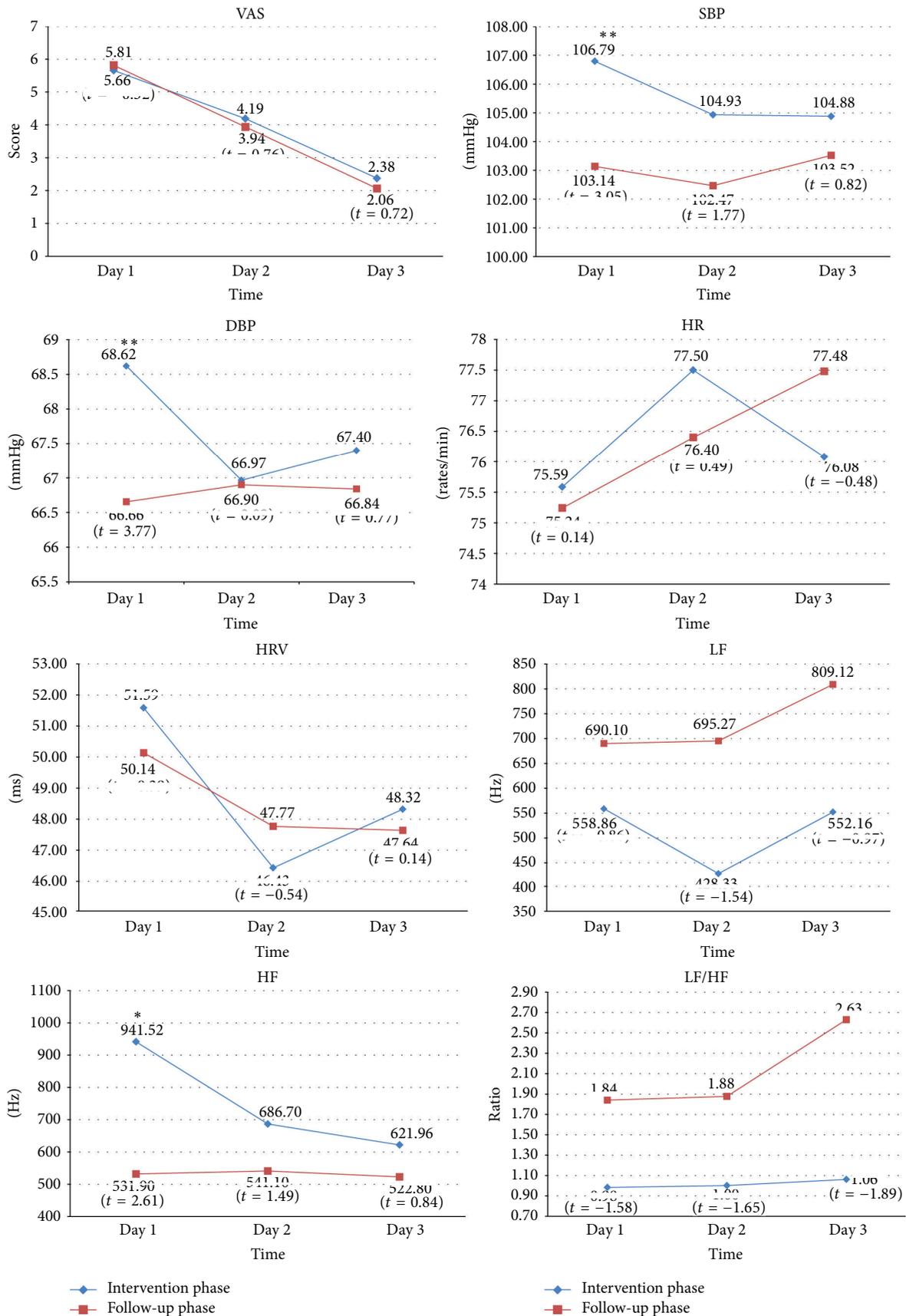


FIGURE 2: The comparison of VAS and physiological parameters on days 1-3, * $P < 0.05$, ** $P < 0.01$.

menstrual distress. It is not surprising this is inconsistent with other studies that found that acupoint stimulation decreased water retention and the autonomic reactions of menstrual distress [53, 54].

This study supports the effect of auricular acupressure to effectively maintain the autonomic homeostasis in young women with primary dysmenorrhea, in terms of increasing the HF activity that regulates the menstrual cycle, but not LH activity or the LF/HF ratio. This is in agreement with other studies in postmenopausal women with insomnia [55] and in healthy adults [56, 57]. Auricular acupressure may stimulate the auricular branch of the vagus nerve, leading to an increase in parasympathetic activity and modifying both autonomic and central nervous system activity [58]. HF reflects vagal activity that contributes to the maintenance of homeostasis during menstrual pain. This finding is similar to that of other studies in which HRV was increased and LF/HF ratio was unchanged in healthy adults [57] and individuals with chronic insomnia [59], while sympathetic activity remained unchanged in healthy adults [56]. In contrast, LF signals reflect sympathetic activity. Other studies have found an increase in LF due to an increase in the intensity of the BP regulatory mechanism [60] or a decrease in LF due to response for improving insomnia [55]. In comparison to the reference LF/HF ratio of 0.8 to 1.5, we measured ratios of 0.98 to 1.06 in the intervention phase and 1.84 to 2.63 in the follow-up phase, which indicate a balance of sympathetic and vagal activity during the intervention phase. Therefore, this finding indicates that auricular acupressure increases parasympathetic activity and regulates the homeostasis of autonomic function in young women with primary dysmenorrhea.

Systolic and diastolic BP, but not HR, was significantly elevated on day 1 between two phases. This is inconsistent with previous studies that reported either a decrease [57] or no change in BP [61, 62]. Many studies have shown a decrease in HR for healthy adults [57, 60], individuals with chronic insomnia [59], and those experiencing anxiety associated with dental extractions [63]. Others have reported no change in HR for healthy adults [56, 61] and those experiencing anxiety before surgery [62]. Activating the vagus nerve typically causes a reduction in HR and BP [58]. However, in the presence of pain and stress, HR and BP are increased in response to vagus nerve stimulation [16, 23]. Accordingly, participants with high stress and pain in the intervention phase could activate sympathetic reactions, leading to an elevation of BP, while HR would remain unchanged due to acupoint-stimulation related simultaneous activation of the parasympathetic nervous system. Various ages, physical conditions, auricular stimulus doses, and measure time points may lead to different results. In addition, previous studies have shown no relationship between HR and pain perception in women [33]. Thus, HR may not be an appropriate indicator of pain outcome for women [62].

5.1. Limitations. This study has some limitations. The absence of a control group and baseline measurements makes it difficult to directly relate the outcome measures to the interventions. In addition, a small sample population was

from a single college, which limited our ability to perform subgroup analysis (such as mild, moderate, and severe pain), and the extent to which the results can be generalized. Because the intervention was given during one menstrual period and the outcomes were measured over two cycles only, the long-term effects are unknown.

6. Conclusion

Auricular acupressure is an effective noninvasive intervention that increases HF to maintain autonomic function homeostasis in young women with primary dysmenorrhea. It may be valuable in alleviating menstrual pain and menstrual distress in high-life stress conditions. Life stress can increase menstrual pain and impact the effect of auricular acupressure. Increasing the simulation requirement of auricular acupressure in high life stress conditions should be considered. Further studies considering stress, using a longitudinal randomized-controlled design, expanding recruiting sites, enlarging sample sizes, involving individuals with differences in the severity of dysmenorrhea, modifying intervention doses, and increasing additional endpoints of timing should be considered.

Authors' Contribution

Mei-Ling Yeh and Jang-Geng Lin contributed equally to this work as cocorrespondence authors.

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