

Effects of Taijiquan Practice on Gastrointestinal Function: An Infrared Thermographic Study Based on Acupoint Theory

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Abstract. Chen-style Taijiquan is a traditional mind–body exercise integrating coordinated movement, breathing regulation, and waist-centered rotation, yet its acute effects on gastrointestinal function remain unclear. This study investigated whether a single session of Chen-style Taijiquan could modulate gastrointestinal activity using infrared thermal imaging and bowel sound assessment. Thirty healthy participants aged 8–22 years with prior Chen-style Taijiquan experience completed a 120-minute session of Laojia Yilu. Skin temperatures at bilateral Zusanli (ST36), bilateral Tianshu (ST25), Zhongwan (CV12), and Baihui (GV20) were measured before and after exercise using infrared thermal imaging. Bowel sounds were auscultated for one minute before and after intervention. After Taijiquan practice, significant temperature increases were observed at gastrointestinal-related acupoints, including bilateral ST36, right ST25, and CV12 (all $P < 0.05$), while GV20 showed no significant change. Baseline bowel sound frequency was significantly correlated with temperatures at ST36, ST25, and CV12. In addition, bowel sound frequency increased markedly after exercise, from 4.3 ± 1.15 to 7.1 ± 2.0 times/min ($P < 0.0001$). These findings suggest that Chen-style Taijiquan can acutely enhance gastrointestinal activity, reflected by increased bowel sounds and elevated thermal responses at gastrointestinal-related acupoints. The region-specific thermal changes further indicate targeted physiological modulation. By integrating infrared thermal imaging with bowel sound assessment, this study provides a novel non-invasive and objective approach for evaluating the gastrointestinal effects of traditional mind–body exercise.

Keywords: Chen-style Taijiquan, infrared thermal imaging, acupoint, gastrointestinal function

1. Introduction

Recently, an increasing number of biomedical imaging and multi-scale analytical techniques have been developed to study chronic diseases usually treated with traditional Chinese medicine (TCM) such as diseases of metabolism, the gastrointestinal tract and respiratory tract. Infrared thermal

imaging (IRT) is a non-invasive, non-contact, and inexpensive method that allows the visualization of radiative energy of the body surface and serves as an indirect temperature of the skin [1, 2]. Compared with the surrounding non-acupoint tissues, acupoints are reported to have a higher local temperature, lower electrical resistance and higher ATP-related metabolic activity, which may possibly imply that they may serve as surface markers of detectable functional changes [3-7]. Hence, the application of thermal profiling to the IR spectral analysis of biomolecules in meridians and acupoints has witnessed an increasing interest [8-10].

Gastrointestinal disorders are common chronic diseases that cause significant physical and psychological impairment. The normal functioning of the gastrointestinal (GI) tract is necessary for digestion, absorption of nutrients, metabolic homeostasis, and good health. Yet, rapid lifestyle changes, irregular eating patterns and ever-increasing psychosocial stresses have led to the prevalence of spleen–stomach disharmony in the conceptual frame of TCM. Such impairment could reduce the efficiency of digestion, interfere with nutrient processing and potentially induce system-wide manifestations, including psychological and emotional stress. Tai Chi is a form of low intensity mind – body exercise involving a series of coordinated body posture and movement, breath regulation, and attentional control. Growing evidence shows that Tai Chi can promote cardiopulmonary function, peripheral circulation, musculoskeletal condition, emotional regulation, cognitive function and social adaptation [11, 12]. It has been successfully adopted as an adjunct therapy for chronic ailments such as hypertension, diabetes, Parkinson's disease, cognitive impairment, sleep disorder, and sarcopenia [13-19]. Nevertheless, direct evidence of its impact on gastrointestinal motility is still scarce [20-22], and a small number of randomized controlled trials have demonstrated alterations in gut microbiota diversity after practice of Tai Chi [23]. Thus, the current study investigated the immediate effect of Tai Chi on gastrointestinal function by detecting gastrointestinal related acupoints such as Zusanli (ST36), Tianshu (ST25), and Zhongwan (CV12), which are widely employed in spleen–stomach diseases [24-26]. Alterations in the acupoint temperature have been previously employed in monitoring responses to drug [27-29], physical and exercise interventions. As a non-contact and objective way to measure body-surface temperature distribution, infrared thermal imaging can be a practical method to evaluate acupoint-specific thermal responses to Tai Chi practise. This occurs in parallel with recording of bowel sounds as a measure of intestinal motility.

2. Literature review

Past research has confirmed Taijiquan's positive regulatory effects on multiple physiological and mental indicators, yet evidence regarding its acute gastrointestinal modulation and associated acupoint thermal specificity remains limited, while this study innovatively combines infrared thermography and bowel sound monitoring to quantitatively verify that single Chen-style Taijiquan practice specifically enhances gastrointestinal acupoint thermal responses and intestinal contractility, providing a new TCM-based physiological model for explaining the benefits of mind-body exercise.

3. Methodology

3.1. Study participants

The participants were recruited from experienced Chen-style Tai Chi practitioners. There were 30 healthy subjects aged from 8 to 22 years. All had no past history of chronic, organic, or infectious disease, and none had experienced fever or its related symptoms within 1 week prior to testing.

They were free from; a) any psychiatric condition, b) organic disease affecting, the heart, liver, lungs or kidney or the haematopoietic system, or c) drug abuses or addictions.

3.2. Intervention

Prior to the assessment, the participants were asked to avoid excessive fluid intake, alcohol consumption, and medication use to prevent any influence on the results. The Tai Chi program was taught by a qualified Chen-style Tai Chi master and the total duration including warm-up and rest breaks was 120 minutes. The session included three parts: warm-up exercises, the Tai Chi practice and relaxation exercises. To measure the immediate effects of Tai Chi practice, the outcome was assessed right before and after the intervention.

3.3. Statistical analysis

GraphPad Prism 10 software was used for the statistical analysis. The data are reported as mean $\pm$ standard deviation ($\bar{x} \pm s$). For within-subject comparisons, normally distributed data were compared using the paired t-test, while the Wilcoxon signed-rank test was used for non-normally distributed data. A P-value of < 0.05 was considered statistically significant.

4. Results

4.1. Subject selection and study process

From recruitment, 30 eligible participants were screened and enrolled. Baseline temperature at the Stomach Majo acupoints and bowel sound frequency were recorded prior to Tai Chi practice. A correlation analysis was conducted to investigate the relationship between temperature of acupoints and frequency of bowel sounds to determine if the latter could supply additional evidence supporting the link of acupoint temperature with gastrointestinal function. The same measures were obtained following the Tai Chi intervention. Thermal changes in acupoints and bowel sound frequency pre/post-intervention were evaluated for the acute influence of Tai Chi practice by employing paired statistical tests (Figure 1).

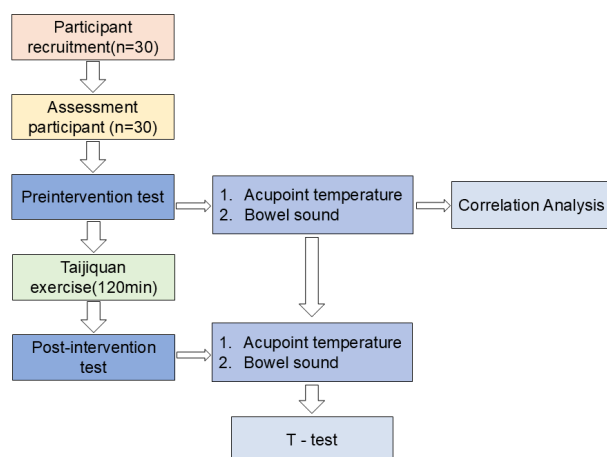


Figure 1. Flow chart of participant recruitment and test

4.2. Infrared thermographic evaluation of stomach meridian acupoints

The Indian researchers report that the infrared thermography-based assessment of body surface temperature is more accurate and has better spatial resolution than the assessment obtained using the traditional contact thermometers and non-contact infrared thermometer for forehead. With this method, the temperatures at the bilateral Zusanli (ST36), bilateral Tianshu (ST25), Zhongwan (CV12), and Baihui (GV20) acupoints were detected, and the acupoint temperature data before and after the intervention were obtained for analysis (Figure 2).

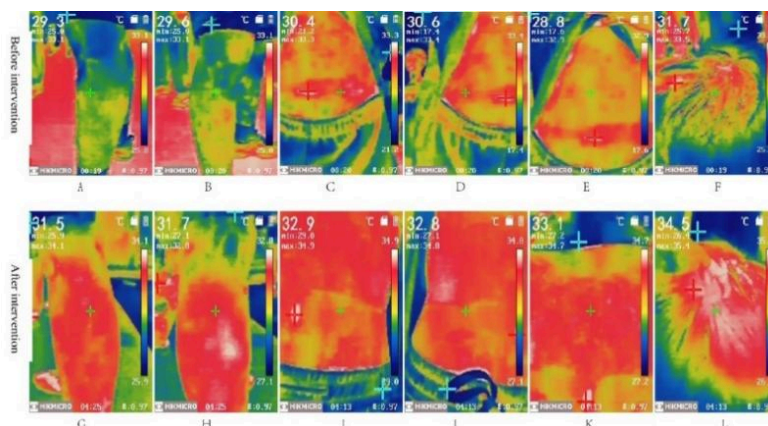


Figure 2. Infrared thermal imaging images

4.3. Tai Chi practice increases stomach meridian acupoint temperature

According to the given information, with Chen-style Tai Chi Laojia Yilu, practitioners demonstrated skin surface temperature changes at Zusanli (ST36), Tianshu (ST25), Zhongwan (CV12), and Baihui (GV20). There were significant differences in the mean temperatures of Zusanli, right Tianshu and Zhongwan preintervention and postintervention, but not for Baihui (Figure 3).

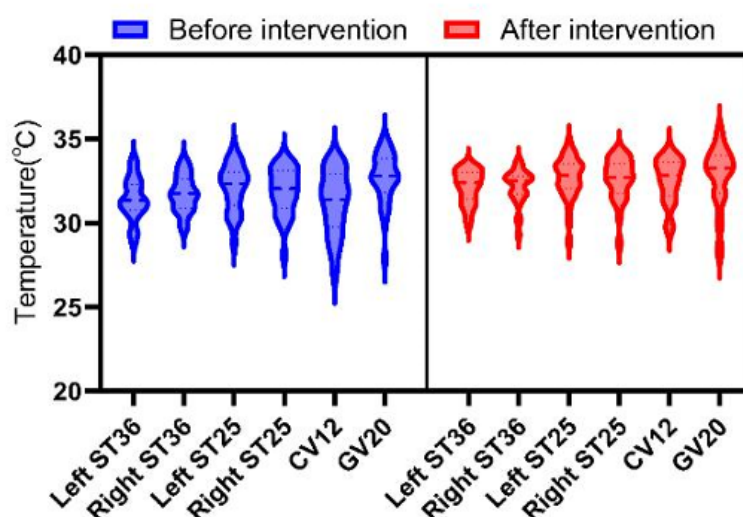


Figure 3. Trend plot of mean $\pm$ SD acupoint temperature

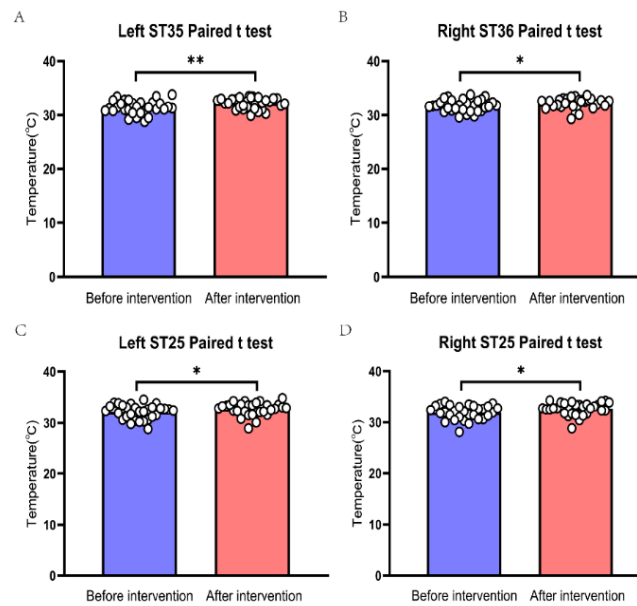


Figure 4. Changes in acupoint temperature before and after Chen-style Tai Chi intervention

As depicted in Figure 4, There is a general trend in the ST of Zusanli, Tianshu, and Zhongwan during post-intervention was an increasing pattern. The temperature at the left Zusanli (ST36) was elevated significantly after the treatment. In the same manner, a statistically significant difference was also found for the temperature of right Zusanli (ST36). The temperature of the left Tianshu (ST25) rose but the change was not significant. There was a significant increase in the temperature of the right Tianshu (ST25).

4.4. Tai Chi practice increases bowel sound activity

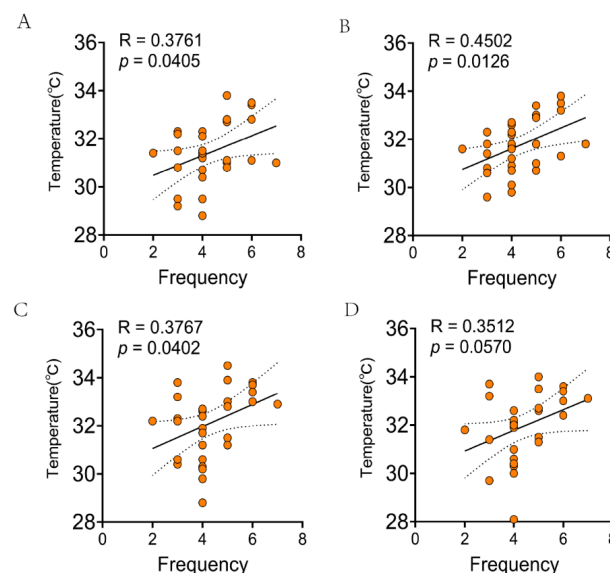


Figure 5. Correlation analysis between acupoint temperature and bowel sound frequency before the intervention

The temperature of a selected acupoints, FBS and FDS were assessed before Tai Chi practices, then bivariate correlation was conducted (Figure 5). Results there were that bowel sound frequency was positively correlated with the temperature of left Zusanli (ST36), right Zusanli (ST36), left Tianshu (ST25), and Zhongwan (CV12) acupoint.

Bowel sound frequency increased markedly upon Tai Chi practice. The analysis showed a highly significant rise following treatment ($P < 0.001$). The bowel sound frequency increased from 4 times/min at rest prior to training to 7 times/min after training (Figure 6). These data indicate that the Tai Chi exercise increased the bowel sound frequency and supported that the temperature variation at the major acupoints between pre- and postintervention may be associated with gastrointestinal motility.

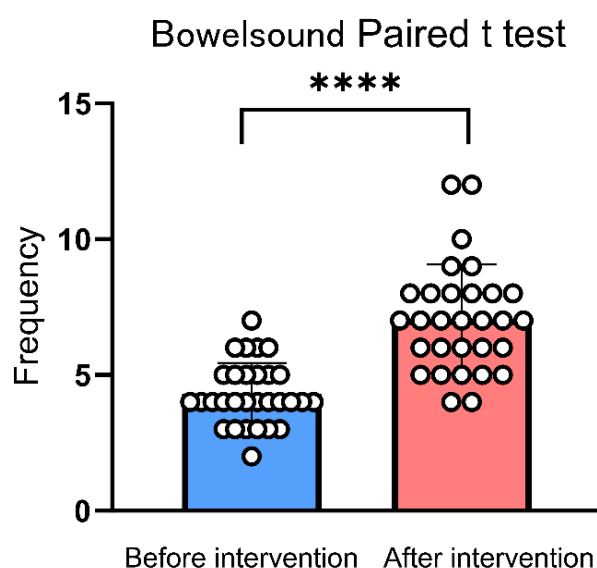


Figure 6. Changes in bowel sound frequency before and after the intervention

5. Discussion

The results of the present study indicated that Taijiquan training could significantly increase the skin temperature at Zusanli, Tianshu, and Zhongwan acupoints, while there was no obvious fluctuation at Baihui. Such localized thermal responses could reflect locally enhanced microcirculation due to exercise. Thermoregulation in humans is a complex process that is partly governed by autonomic and vascular mechanisms, including cutaneous vasodilation and evaporative heat loss during exercise. Significantly, Zusanli, Tianshu and Zhongwan have been considered secret acupoints in TCM liquid therapy for the regulation of the gastrointestinal tract and the maintenance of whole body balance. In addition to temperature variations seen in gastrointestinal-related acupoints, the rate of bowel sounds notably accelerated after Taijiquan from about 4 to 7 times per minute. In this regard, this result indicated a transient increase in gastrointestinal motility after exercise.

6. Conclusion

This study indicates that Chen-style Taijiquan practice had significant influence on acupoint skin temperatures and gastrointestinal motility.

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