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Original Article

# Characteristic patterns of normal meridian acupoint temperature

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**Abstract**

*Background*: Body temperature is an important indicator of health and illness. However, a single temperature measurement is not always reliable. Such measurements can be made using meridians, which are energy channels with acupoints being the nodes. To date, there is no published reference of meridian acupoint temperatures applicable to human health, and there is no clear digitalized indicator that could be utilized to evaluate human health by way of meridian acupoints up to now.

*Methods*: Our study recruited 100 healthy medical college students for the measurement of acupoint temperature. The temperatures of 135 acupoints of 14 main meridians were measured using infrared thermometers in order to provide a comprehensive body temperature reading of each study participant.

*Results*: The degree of the acupoint temperature consistently ranged from 34.88°C to 36.14°C. The gross thermograph was concentric, with high degree readings around the heart and low degree readings originating from the feet. The left and right body sides had significant correlation between the degrees of bilateral same name acupoint temperatures of 12 regular meridians (correlation coefficient, 0.367–0.985; $p < 0.0001$). There was also a significant correlation between the acupoint temperature for the governor vessel and the conception vessel (correlation coefficient, 0.083; $p = 0.006$).

*Conclusion*: These findings indicate that meridian acupoint temperature is characterized by a consistently narrow range, as well as concentricity and symmetry in body temperature degree readings in college students. Meridian acupoint temperature may be a sensitive and valuable indicator to assist in the accurate evaluation of meridian and general human health, and the significance and changes of acupoint temperature in clinical conditions warrants future exploration.



*Keywords:* acupoint; medical college students; meridian; skin temperature; symmetry

## 1. Introduction

Our previous research indicated that Chinese medicine and acupuncture demonstrated a similar efficacy for treatment of obesity as Western antiobesity drugs, but with fewer reported effects.[1] Meridian and acupoint are the unique systems recorded in *The Yellow Emperor's Internal Classic* or *Canon of Medicine*, and are considered to be energy channels with acupoints being the nodes in modern medicine.[2–4] Body temperature closely relates to energy metabolism, and it is generally understood that a quick evaluation of a person's health can be accomplished by measuring oral or axillary temperatures. However, single temperature reading is not always reliable. A patient with furunculosis may have a normal core body temperature, but the skin temperature around furunculosis may be feverish.[5] A patient with lower extremity varicose veins may have normal axillary temperature, but the feet may feel almost icy to the touch.[6] Owing to the properties

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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of meridian and acupoint, we conjecture that skin temperature of meridian acupoint may be a good parameter to help evaluate health condition. Some studies have described some acupoint skin temperatures, but they merely focused on only one or two meridians.[4,7] There is no standard of meridian acupoint temperature and no clear digitalized indicator to evaluate health associated with meridians to date. In this study, we have summarized the characteristics of 14 main meridians acupoint temperatures and have established a meridian acupoint temperature map. In addition, meridian theory is the foundation of traditional Chinese medicine (TCM) and acupuncture. Skin temperature of meridian acupoint may also provide clearly valuable information for TCM formula modification and acupoint combination for the treatment.

## 2. Methods

### 2.1. Participants

The study processes were performed in accordance with international ethical standards and was approved by the Ethics Committee of Guilin Medical University Affiliated Hospital (approval No.: GLMC15032013HL). All participants fully understood the procedure and the purpose of this noninvasive test, and they took part in the study voluntarily. All patients provided written and signed informed consent documents before they were admitted to the university's clinical research center.

The study included 100 healthy medical college students (50 males and 50 females), aged $20.65 \pm 1.53$ years, with a weight range of $55.67 \pm 8.33$ kg. The participants met the following requirements: (1) age, between 18 years and 25 years; (2) weight, between 45 kg and 65 kg; (3) no smoking, no alcohol use, no drug use, no addiction to network; (4) vital signs of the individual including heart rate, breath rate, pulse rate, and blood pressure are normal, and the individual is proven to be healthy without illness in important organs (lung, heart, liver, and kidney) after undergoing physical examination in Guilin Medical University Affiliated Hospital; laboratory examination results (including liver function test, kidney function test, blood glucose, blood lipids, blood red cell, and blood white cell) were normal; (5) besides the requirements above, females needed to meet the requirements of duration of menstruation of $28 \pm 7$ days, with no uncomfortable symptoms of breast pain, diarrhea, hypogastralgia, and insomnia in the premenstrual and menstrual cycle, no pregnancy, no problem in the reproductive system proved by B ultrasonic examination, and leukorrhea routine examination, and need to avoid menstruation.

### 2.2. Design

The skin temperature of 135 acupoints of 14 main meridians was measured by an infrared thermometer (DT-8806H; Shenzhen Everbest Machinery Industry Co. Ltd., Shenzhen, China). Prior to use, the thermometer was validated for accuracy against a standard thermometer certified by National Bureau of Standards and accurate to 0.2°C. The 135 acupoints of 14 main meridians are shown in Table 1, and elucidated in the human body as noted in Fig. S1.

Table 1
135 acupoints of 14 main meridians in the study.

| Meridian | Acupoint |
|---|---|
| Lung meridian (LU) | Zhongfu (LU1), Chize (LU5), Kongzui (LU6), Lieque (LU7), Jingqu (LU8), Taiyuan (LU9), Yuji (LU10), Shaoshang (LU11) |
| Large intestine meridian (LI) | Shangyang (LI1), Erjiang (LI2), Sanjiang (LI3), Hegu (LI4), Yangxi (LI5), Wenliu (LI7), Quchi (LI11), Jianyu (LI15), Yingxiang (LI20) |
| Stomach meridian (ST) | Chengqi (ST1), Dicang (ST4), Xiaguan (ST7), Touwei (ST8), Liangmen (ST21), Tianshu (ST25), Futu (ST32), Liangqiu (ST34), Zusanliu (ST36), Tiaokou (ST38), Xiajuxu (ST39), Jiexi (ST41), Chongyang (ST42), Xiangu (ST43), Neiting (ST44), Lidui (ST45) |
| Spleen meridian (SP) | Yinbai (SP1), Dadu (SP2), Taibai (SP3), Gongsun (SP4), Shangqiu (SP5), Sanyinjiao (SP6), Diji (SP8), Yinlingquan (SP9), Xuehai (SP10), Daheng (SP15), Dabao (SP21) |
| Heart meridian (HT) | Jiquan (HT1), Shaohai (HT3), Lingdao (HT4), Yinxi (HT6), Shenmen (HT7), Shaofu (HT8), Shaochong (HT9) |
| Small intestine meridian (SI) | Shaoze (SI1), Qiangu (SI2), Houxi (SI3), Wanggu (SI4), Yanggu (SI5), Zhizheng (SI7), Xiaohai (SI8), Tianzong (SI11), Tinggong (SI19) |
| Bladder meridian (BL) | Jiangmin (BL1), Dazhu (BL11), Feishu (BL13), Xinshu (BL15), Geshu (BL17), Ganshu (BL18), Danshu (BL19), Pishu (BL20), Weishu (BL21), Sanjiaoshu (BL22), Shenshu (BL23), Dachangshu (BL25), Xiaochangshu (BL27), Pangguangshu (BL28), Weizhong (BL40), Chengshan (BL57), Kunlun (BL60), Jinggu (BL64), Shugu (BL65), Zutonggu (BL66), Zhiyin (BL67) |
| Kidney meridian (KI) | Yongquan (KI1), Rangu (KI2), Taixi (KI3), Zhaohai (KI6), Fuliu (KI7), Yingu (KI10), Dahe (KI12), Huangshu (KI16) |
| Pericardium meridian (PC) | Quze (PC3), Ximen (PC4), Jianshi (PC5), Neiguan (PC6), Daling (PC7), Laogong (PC8), Zhongchong (PC9) |
| Triple energizer meridian (TE) | Guangchong (TE1), Yemen (TE2), Zhongzhu (TE3), Yangchi (TE4), Waiguang (TE5), Zhigou (TE6), Tianjing (TE10), Jianliao (TE14) |
| Gallbladder meridian (GB) | Fengchi (GB20), Riyue (GB24), Fengshi (GB31), Yanglingquan (GB34), Xuanzhong (GB39), Qiuxu (GB40), Zulingqi (GB41), Xiaxi (GB43), Zuqiaoyin (GB44) |
| Liver meridian (LR) | Dadun (LR1), Xingjian (LR2), Taichong (LR3), Zhongfeng (LR4), Ququan (LR8), Zhangmen (LR13), Qimen (LR14) |
| Governor vessel (GV) | Mingmen (GV4), Zhiyang (GV9), Dazhui (GV14), Fengfu (GV16), Baihui (GV20), Shangxing (GV23), Suliao (GV25), Shuigou (GV26) |
| Conception vessel (CV) | Zhongji (CV3), Guanyuan (CV4), Qihai (CV6), Shenque (CV8), Zhongwan (CV12), Juque (CV14), Danzhong (CV17) |

Participants had their breakfast between 7:30 AM and 8:00 AM, fasted for 2 hours, and had their acupoint skin temperatures measured between 10:00 AM and 11:00 AM in the same sequence of acupoint after lying on the bed for 15 minutes in the clinic research center of Guilin Medical University Affiliated Hospital. The environmental condition of the clinic research center was controlled at a room temperature of 26 ± 0.1°C, humidity of 60 ± 10%, and barometric pressure of 1 mmHg. Every acupoint temperature was measured three times and was recorded as the mean value. The measurement was carried out from May 3 to May 14, 2013.

Data were expressed as mean ± standard deviation and analyzed using SPSS 18.0 (SPSS version 18, SPSS Inc., Chicago, IL).

## 3. Results

### 3.1. Consistency and concentricity of acupoint temperature

We measured a total of 135 acupoint skin temperatures in the study, which covered 37.4% of all classic acupoints. The ratio between measured acupoints and total acupoints of a meridian was from 20.5% to 77.8%, as shown in Table 2. The mean temperatures of 14 main meridians are shown in Table 3, with temperatures ranging from 35.50°C to 36.06°C. The mean temperature values of conception vessel and governor vessel were higher, which were higher than 36°C. The mean temperatures of lung meridian, large intestine meridian, stomach meridian, heart meridian, bladder meridian, pericardium meridian, and triple energizer meridian were around 35.85°C, whereas the mean temperatures of spleen meridian, kidney meridian, gallbladder meridian, and liver meridian were around 35.55°C.

The mean temperature of each measured acupoint is shown in Figs. 1–7. The temperatures of these acupoints were in a narrow range of 34.88–36.14°C. The average temperature of all measured acupoints was 35.76 ± 1.13°C. There were three temperature peaks: 36.14°C at right LUI (Fig. 2), 36.12°C at right HT1 (Fig. 4), and 36.11°C at CV8 (Fig. 7). There were also three temperature valleys: 34.88°C at the right LR1 (Fig. 1), 35.10°C at the left SP1 (Fig. 3), and 35.13°C at the left BL67 (Fig. 5).

Table 2
Ratio between the measured acupoints and the total acupoints of 14 main meridians.

| Meridian | No. of measured acupoint | No. of total acupoint | Percentage |
|---|---|---|---|
| LU | 8 | 11 | 72.7 |
| LI | 9 | 20 | 45 |
| ST | 16 | 45 | 35.6 |
| SP | 11 | 21 | 52.4 |
| HT | 7 | 9 | 77.8 |
| SI | 9 | 19 | 47.4 |
| BL | 21 | 67 | 31.3 |
| KI | 8 | 27 | 29.6 |
| PC | 7 | 9 | 77.8 |
| TE | 8 | 23 | 34.8 |
| GB | 9 | 44 | 20.5 |
| LR | 7 | 14 | 50 |
| GV | 8 | 28 | 28.6 |
| CV | 7 | 24 | 29.2 |
| Total | 135 | 361 | 37.4 |

Percentage = number of measured acupoint/number of total acupoint × 100.

Table 3
Correlation and difference analysis of 14 main meridians temperatures.

| Meridian | Temperature (°C) | | | $r$[a] | $p$[b] |
|---|---|---|---|---|---|
| | Left | | Right | | |
| LU | 35.82 ± 0.41 | — | 35.86 ± 0.38 | 0.869 | <0.001 |
| LI | 35.89 ± 0.37 | — | 35.91 ± 0.37 | 0.916 | 0.004 |
| ST | 35.84 ± 0.44 | — | 35.84 ± 0.42 | 0.838 | 0.638 |
| SP | 35.59 ± 0.66 | — | 35.57 ± 0.69 | 0.875 | 0.128 |
| HT | 35.83 ± 0.51 | — | 35.82 ± 0.48 | 0.925 | 0.989 |
| SI | 35.81 ± 0.49 | — | 35.81 ± 0.50 | 0.869 | 0.756 |
| BL | 35.81 ± 0.56 | — | 35.80 ± 0.59 | 0.922 | 0.880 |
| KI | 35.56 ± 0.79 | — | 35.55 ± 0.80 | 0.929 | 0.541 |
| PC | 35.94 ± 0.33 | — | 35.96 ± 0.28 | 0.833 | 0.136 |
| TE | 35.87 ± 0.38 | — | 35.87 ± 0.39 | 0.864 | 0.787 |
| GB | 35.58 ± 0.79 | — | 35.59 ± 0.77 | 0.940 | 0.881 |
| LR | 35.51 ± 1.11 | — | 35.50 ± 1.11 | 0.960 | 0.619 |
| GV | — | 36.04 ± 0.21 | — | 0.083 | 0.006 |
| CV | — | 36.06 ± 0.23 | — | — | — |

Data are expressed as mean ± standard deviation. Values are significantly different for $p < 0.05$.
— = no value.
[a] Correlation ($r$) between the temperature of the left and the right same meridian was analyzed by computing Pearson's correlation coefficient; all $p < 0.0001$. Correlation between the temperature of GV and CV was analyzed by computing Pearson's correlation coefficient; $p = 0.025$.
[b] Difference between the temperature of left and the right same meridian was analyzed by paired-samples $t$ test; difference between temperature of GV and CV was analyzed by independent samples $t$ test.

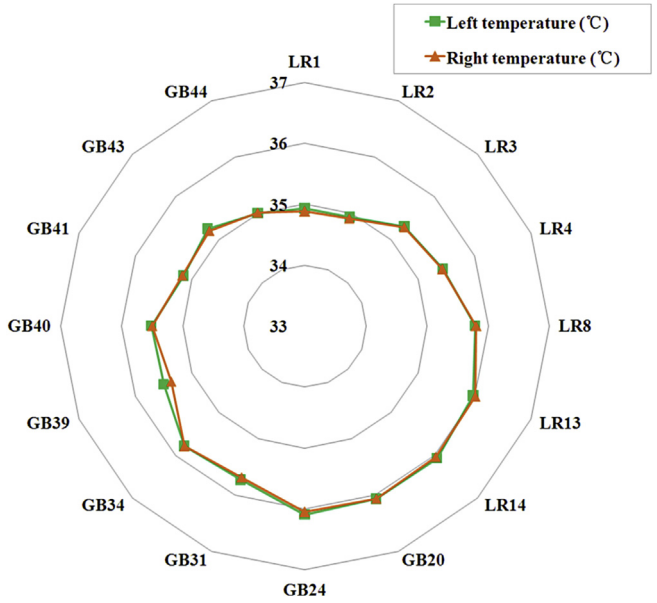


Fig. 1. Skin temperature of gallbladder meridian and liver meridian acupoint. Correlation between the temperature of the left and the right same name acupoint was analyzed by computing Pearson's correlation coefficient. The skin temperature of 16 bilateral same name acupoint showed a significant correlation with correlation coefficient from 0.367 to 0.985 and $p < 0.0001$. Difference between the temperature of left and the right same name acupoints was analyzed by paired-samples $t$ test. Fifteen bilateral same name acupoint temperatures did not show statistical difference except GB39; $p_{GB39} = 0.003$. Values are significantly different for $p < 0.05$.

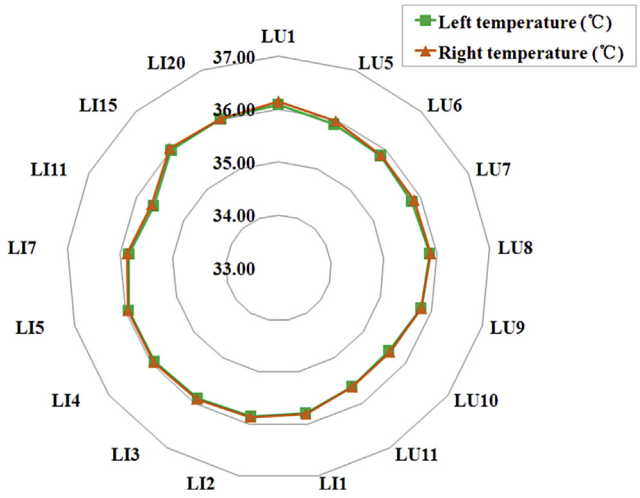


Fig. 2. Skin temperature of lung meridian and large intestine meridian acupoint. Correlation between the temperature of the left and the right same name acupoint was analyzed by computing Pearson's correlation coefficient. The skin temperature of 17 bilateral same name acupoints showed a significant correlation with correlation coefficient from 0.619 to 0.957 and $p < 0.0001$. Difference between the temperature of left and the right same name acupoint was analyzed by paired-samples $t$ test. Fourteen bilateral same name acupoint temperatures did not show statistical difference except LU1, LU5, and LI1; $p_{LU1} = 0.036$, $p_{LU5} = 0.034$, and $p_{LI11} = 0.007$, respectively. Values are significantly different for $p < 0.05$.

Acupoint temperature was related to its position and increased centripetally. The lung meridian started from LU1, locating in the chest, to the end acupoint of LU11 beside the nail of the thumb. The acupoint temperature of it gradually decreased along the channel from 36.09°C of the left LU1 to 35.64°C of the left LU11, and from 36.14°C of the right LU1 to 35.65°C of the right LU11 (Fig. 2). The large intestine meridian started from LI1 locating in the index fingers to the

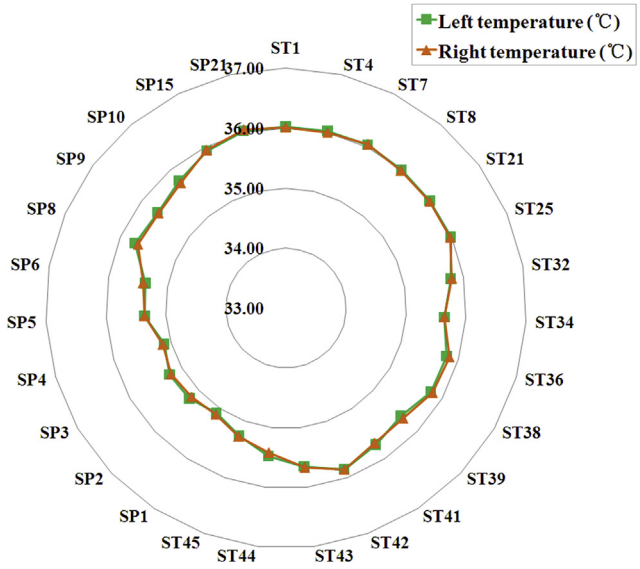


Fig. 3. Skin temperature of stomach meridian and spleen meridian acupoint. Correlation between the temperature of the left and the right same name acupoint was analyzed by computing Pearson's correlation coefficient. The skin temperature of 27 bilateral same name acupoint showed a significant correlation with correlation coefficient from 0.498 to 0.982 and $p < 0.0001$. Difference between the temperature of left and the right same name acupoint was analyzed by paired-samples $t$ test. All 27 bilateral same name acupoint temperatures did not show statistical difference Values are significantly different for $p < 0.05$.

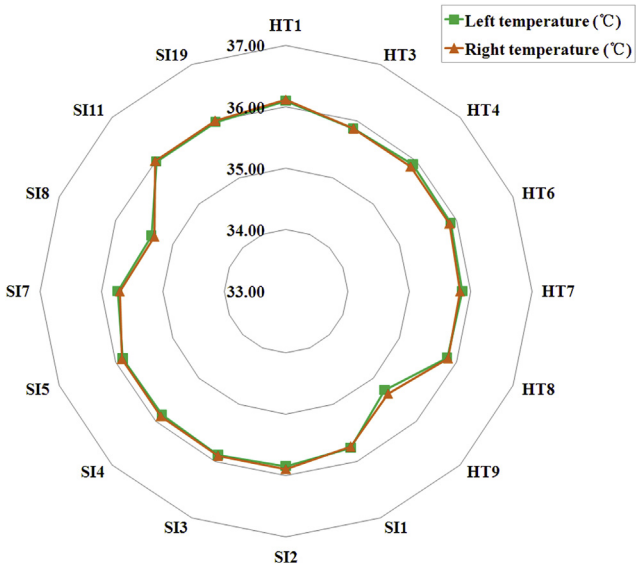


Fig. 4. Skin temperature of heart meridian and small intestine meridian acupoint. Correlation between the temperature of the left and the right same name acupoint was analyzed by computing Pearson's correlation coefficient. The skin temperature of 16 bilateral same name acupoint showed a significant correlation with correlation coefficient from 0.638 to 0.967 and $p < 0.0001$. Difference between the temperature of left and the right same name acupoint was analyzed by paired-samples $t$ test. All 16 bilateral same name acupoint temperatures did not show statistical differences. Values are significantly different for $p < 0.05$.

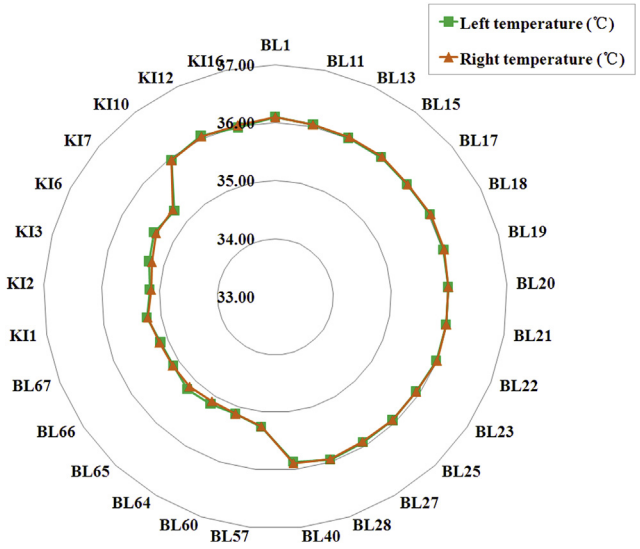


Fig. 5. Skin temperature of bladder meridian and kidney meridian acupoint. Correlation between the temperature of the left and the right same name acupoint was analyzed by computing Pearson's correlation coefficient. The skin temperature of 29 bilateral same name acupoint showed a significant correlation with correlation coefficient from 0.716 to 0.983 and $p < 0.0001$. Difference between the temperature of left and the right same name acupoint was analyzed by paired-samples $t$ test. All 29 bilateral same name acupoint temperatures did not show statistical difference. Values are significantly different for $p < 0.05$.

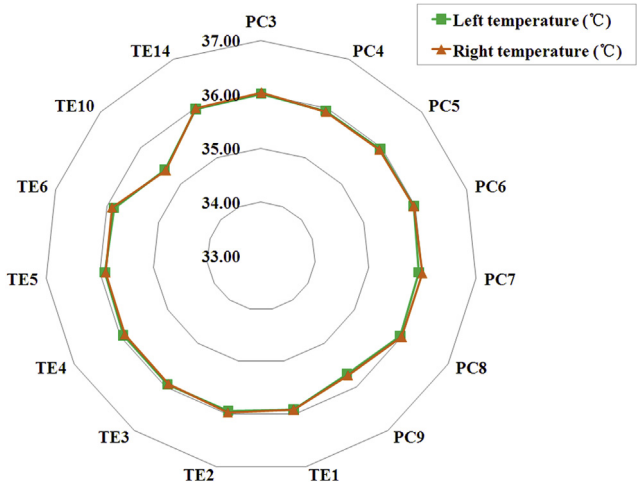


Fig. 6. Skin temperature of pericardium meridian and triple energizer meridian acupoint. Correlation between the temperature of the left and the right same name acupoint was analyzed by computing Pearson's correlation coefficient. The skin temperature of 15 bilateral same name acupoint showed a significant correlation with correlation coefficient from 0.478 to 0.923 and $p < 0.0001$. Difference between the temperature of left and the right same name acupoint was analyzed by paired-samples $t$ test. Thirteen bilateral same name acupoint temperatures showed no statistical difference except PC7 and TE2; $p_{PC7} = 0.006$ and $p_{TE2} = 0.020$, respectively. Values are significantly different for $p < 0.05$.

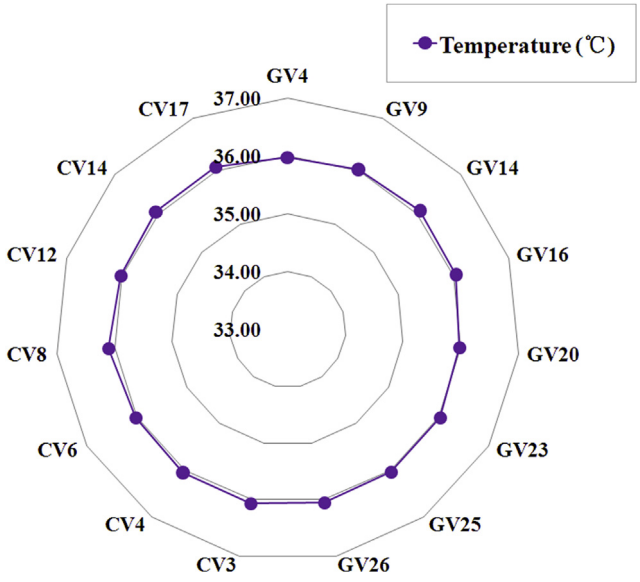


Fig. 7. Skin temperature of governor vessel and conception vessel acupoint. Correlation between the temperature of GV and CV was analyzed by computing Pearson's correlation coefficient. The skin temperature of GV and CV showed a significant correlation with correlation coefficient of 0.083 and $p = 0.006$. Difference between temperature of GV and CV was analyzed by independent samples $t$ test with $p = 0.025$. Values are significantly different for $p < 0.05$.

end acupoint of LI20 beside the nose. The acupoint temperature of this meridian tended to gradually increase along the channel from 35.8°C of the left LI1 to 36.02°C of the left LI20, and from 35.81°C of the right LI1 to 36.02°C of the right LU20 except LI11 (Fig. 2). It was obvious that the acupoint temperature gradually declined along the channels of the stomach meridian (Fig. 3), heart meridian (Fig. 4), bladder meridian (Fig. 5), pericardium meridian (Fig. 6), and gallbladder meridian (Fig. 1), but gradually increased along the channels of the spleen meridian (Fig. 3), kidney meridian (Fig. 5), and liver meridian (Fig. 1). The acupoint temperatures of the small intestine meridian were recorded consistently at around 35.8°C, except SI8 (Fig. 4), and the acupoint temperatures of the triple energizer meridian were consistently at around 36°C except TE10 (Fig. 6). The acupoint temperatures of governor vessel and conception vessel were really consistently around 36°C (Fig. 7). We divided the acupoints into groups according to body parts, and found that temperatures of acupoints were distributed concentrically. The chest acupoint group had the highest temperature of 36.04°C, followed by, in turn, the head acupoint group of 36.03°C, belly acupoint group of 36°C, forearm acupoint group of 35.85°C, hand acupoint group of 35.82°C, thigh acupoint group of 35.73°C, shank acupoint group of 35.68°C, and feet acupoint group of 35.3°C. The temperature of the chest acupoint group was not significantly different from that of the head acupoint group, but did have a significant difference with the other groups (Table 4).

### 3.2. Symmetry of meridian acupoint temperature

The skin temperatures of all measured gallbladder meridian acupoints showed a significant correlation in the bilateral same name acupoints, with a correlation coefficient ranging from 0.709 to 0.957 ($p < 0.0001$), and difference analysis indicated that they did not have any difference except for GB39 (Fig. 1). The skin temperatures of all measured liver meridian acupoint showed a significant correlation in bilateral same name acupoints with a correlation coefficient from 0.367 to 0.985 ($p < 0.0001$), and difference analysis showed they did not demonstrate a significant difference (Fig. 1).

Correlation analysis and difference analysis of skin temperatures of bilateral same name acupoints of other meridians are shown in Figs. 2–6.

The skin temperature of all bilateral same name acupoints showed a significant correlation, with a correlation coefficient ranging from 0.367 to 0.985 ($p < 0.0001$) in our study. Additionally, 95% (114/120) of the bilateral acupoints

Table 4
Difference analysis of acupoint groups' temperatures in different parts of body.

| Acupoint group | Temperature (°C) | $p$ |
|---|---|---|
| Head | 36.03 ± 0.17 | 0.07 |
| Chest | 36.04 ± 0.48 | |
| Belly | 36.00 ± 0.36 | 0.03 |
| Forearm | 35.85 ± 0.17 | <0.001 |
| Hand | 35.82 ± 0.57 | <0.001 |
| Thigh | 35.73 ± 0.63 | <0.001 |
| Shank | 35.68 ± 0.71 | <0.001 |
| Feet | 35.30 ± 0.63 | <0.001 |

Data are expressed as mean ± standard deviation. Values are significantly different for $p < 0.05$.
Difference between temperature of each acupoint group and chest acupoint group was analyzed by independent samples $t$ test.

temperatures had no statistic difference in the left and the right except LU1, LU5, LI1, PC7, TE2, and GB39 (Figs. 1–6). Each left meridian acupoint temperature curve was parallel and symmetric to that of the right one. The temperature of paired bilateral acupoints, including Back-Shu points, Coupled points, Xi cleft points, Luo connecting points, Five Shu points, and source point of the 12 regular meridians showed symmetry and correlation to the left and right sides as well (Figs. 1–6, Fig. S2). The temperature of the governor vessel had a significantly positive correlation with that of the conception vessel, with $p = 0.025$ (Fig. 7).

## 4. Discussion

For the first time, we report the characteristics of meridian acupoint temperatures in healthy medical college students, from which we can construct a meridian acupoint temperature map. The map vividly shows that the acupoint temperature is consistent within a narrow range to maintain the body warmness; the acupoint temperature is symmetric with bilateral correlation for the left and right sides. The acupoint temperature of the governor vessel is symmetric to that of the conception vessel (Fig. S2).

A single temperature reading is not sufficient to exactly reflect the temperature difference over the entire body, whereas meridian acupoint temperature could overcome this problem. The human body temperature keeps its core temperature constant at about 37°C by physiological regulation, which is controlled by the hypothalamus and associated with the balance between blood flow and metabolism according to the "heat removal" theory.[8,9] Only the "dead body" temperature varies with environmental temperature, a reading that is always cold. In our study, we measured 135 acupoint skin temperatures and found that they remained consistently within a range of 34.88–36.14°C, but had a difference among them with concentricity distribution. Skin temperatures of acupoints located in the head, chest, and belly were higher (Table 4). The governor vessel and conception vessel distribute along the head and trunk axis line. The human brain weight represents 4–5% of body weight, but its blood flow volume covers 15–20% of the cardiac output.[10] Important organs, such as the heart, lung, liver, spleen, intestine, and kidney, are in the chest and belly. Blood flow volume of the heart and lung is responsible for about 15% of the cardiac output.[11,12] Liver, spleen, and intestine reserve abundant blood[13]; therefore, acupoint skin temperatures of these sections were correspondingly higher. In this study, the temperatures of three acupoints—LI11, SI8, and TE10—did not meet the trend of their whole meridian temperature. In fact, they were much lower than that of the adjacent acupoint temperature. This is the first study to report on this phenomenon. It is generally understood that LI11 names quchi, SI8 xiaohai, and TE2 tianjing. Furthermore, it is interesting to note that the meanings of their names are all related to water. Indeed, water is an important mediator to transfer energy, as the heat always flows from a higher to a lower temperature. Water temperature can affect the metabolic rates and biological activity of human bodies by maintaining energy homeostasis. However, metabolic rates and biological activity of the holistic human body can change the water temperature. Transformation of the drinking water into circulating blood, where after the circulating blood transforms into sweat and urine is mutually associated with human metabolism and physiology. However, further studies are necessary to explore the mechanisms underlying this novel finding.

It is well known that an important therapy in TCM is moxibustion. The principle of moxibustion is implemented by clinical applications of penetrating heat on specific meridian channels and acupuncture points of the body, with the intention of stimulating circulation and restoring energy homeostasis. In fact, moxibustion alone, or in combination with acupuncture, may be effective for impaired circulation, cold and damp conditions, and yang deficiency in the body. Indeed, moxibustion has widely been used for the treatment of pain,[14] cancer,[15] stroke,[16] ulcerative colitis,[17] constipation,[18] and hypertension.[19]

Patients living with cancer often have a low body temperature.[6] An animal experiment has shown that direct moxibustion at Ganshu (BL18) could inhibit precancerous lesion and delay the development of liver cancer in a rat model.[20] Premenstrual syndrome symptom can reduce the quality of life of the individual. Both hand acupuncture therapy (HAT) and hand moxibustion therapy (HMT) might significantly reduce overall premenstrual syndrome symptom severity scores. The HMT, but not the HAT, could improve body temperature in the clavicles, chest, lower abdomen, and shoulder, with narrowing temperature discrepancies among their symmetrical locations.[21] Acupoint heat-sensitive moxibustion over bilateral Weizhong (BL 40) might relieve acute knee pain by decreasing serum osteopontin and matrix metalloproteinase-3 levels.[22]

The 12 regular meridians are distributed symmetrically on the left and right sides of the body, and run along their fixed courses. The temperature of paired bilateral acupoints shows symmetry and correlation to the left and right sides. One member of our research group, Bing Xiong, compared the skin temperature of bilateral source points of the 12 regular meridians, and proved symmetry and correlation of temperature in paired acupoints.[23] Following acupuncture of the right LI4, the Hegu acupoint, the change ratio of mean blood flux was increased in the contralateral Hegu acupoint in healthy volunteers for a period ranging from 30 minutes, 60 minutes, to 150 minutes after stimulation.[24] Consistently, manual acupuncture or electroacupuncture at unilateral Zusanli (ST36) and Xiajuxu (ST39) for 6 weeks significantly improved university students' ankle dorsiflexor strength and muscle activation in both legs.[25] Similarly, acupuncture at right Xiaohai (SI8) and Jianwaishu (SI14) all increased electromyographic activity and strength in the ipsilateral and contralateral upper trapezius muscle 20 minutes after needle withdrawal.[26] Moreover, contralateral needling rather than conventional acupuncture at acupoints of Chize (LU5) and Jianliao (TE14) of 106 patients with stroke-induced hemiplegia showed an elevated effective rate as defined by the

decreased neurological deficit score and increased Modified Barthel Index and Fugl-Meyer Assessment score.[27] Last, but not least, pretreatment with electroacupuncture at the left Zusanli (ST36) attenuated inflammatory pain of right lower knee arthritis induced by carrageenan in rats.[28] The totality of these findings highlights the bilateral acupoint symmetry with therapeutic implications.

A study has revealed that acupuncture at Taichong (LR3) specifically activated contralateral middle occipital gyrus, ipsilateral medial frontal gyrus, superior parietal lobe, middle temporal gyrus, rostral anterior cingulate cortex, lentiform nucleus, insula, and contralateral thalamus. Moreover, acupuncture at Neiting (ST44) might selectively activate ipsilateral secondary somatosensory area, contralateral middle frontal gyrus, inferior frontal gyrus, lingual gyrus, lentiform nucleus, and bilateral posterior cingulate cortex.[29] In general, acupuncture can elicit complicated ipsilateral and contralateral cerebral activation patterns, which might be involved in the mechanism of the specific therapeutic effects of different acupoints. Skin conductance and finger temperature of stroke survivors with hemiparesis were statistically higher in the unaffected hand compared with the paralyzed hand. In some cases, the characteristic symmetry feature of skin temperature between the symmetric locations of the human body might fail.[30]

Acupuncture is widely used to treat many diseases, such as obesity,[1] pain relief,[31–34] peripheral facial paralysis,[35] and knee osteoarthritis,[36] and to improve sleep disturbance in perimenopausal and postmenopausal women.[37] It is an effective intervention for managing the symptom of cancer-related fatigue, for prevention of radiation-induced xerostomia among patients with nasopharyngeal carcinoma, and for improving the quality of a patient's life.[33,38,39] However, the efficacy of acupuncture is still a controversial issue.[40] In reports of cancer-related fatigue treated with acupuncture, Alexander Molassiotis and colleagues[38] reported bilaterally or unilaterally ST36, SP6, LI4, GB34, and SP9 with some flexibility by therapists at their discretion to maintain an equal dose of treatment effectively managing the symptom, whereas Gary Deng and colleagues[40] reported bilaterally or unilaterally CV4, CV6, KI3, ST36, SP6, and LI11 without the predefined clinical significance to reduce fatigue. The acupoint combination is exceedingly important for purposes of efficacy during the acupuncture treatment. Up until now, there exists no sufficient digital parameter to judge meridian health condition. Meridians and acupoints are considered energy channels with acupoints being the nodes.[2–4] Laser acupuncture could improve the skin temperature of premature babies and neonates without any risks.[41] Acupuncture stimulation could change the local temperature by improving the local blood supply, but may also increase approximate entropy values and decrease the microcirculatory blood flow variability parameters.[42] Skin temperatures of acupoints may be a sensitive parameter to manifest acupoint and meridian health condition. An infrared thermometer could be widely applied to measure acupoint temperature, with the advantage of noninvasiveness, simplicity, and sensibility.

In general, we measured the skin temperatures of 135 acupoints in healthy students. The skin temperatures of these acupoints had consistency at a narrow range of 34.88–36.14°C, but had differences among them arising in part from concentricity distribution to keep whole body warmness. Skin acupoint temperatures of 12 regular meridians were showed to be symmetric and correlative to the left and the right, but the acupoint temperatures of the governor vessel were symmetric and correlative to that of the conception vessel. These findings indicate that meridian acupoint temperature is characterized by a consistently narrow range, concentricity, and symmetry in healthy people. We constructed a circle map showing acupoint temperatures to vividly demonstrate these characteristics in Fig. S2. Meridian acupoint temperature may be a sensitive and valuable indicator to evaluate meridian health and a person's health. The clinical impact of acupoint temperature disorders warrants future investigation.

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## Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jcma.2016.12.007.

## References

1. Sui Y, Zhao HL, Wong VC, Brown N, Li XL, Kwan AK, et al. A systematic review on use of Chinese medicine and acupuncture for treatment of obesity. *Obes Rev* 2012;**13**:409–30.
2. Lee MS, Lee YH, Shin BC, Jeong DM, Kim MK, Eo YG, et al. Is there any energy transfer during acupuncture? *Am J Chin Med* 2005;**33**:507–12.
3. Zheng SX, Pan XH, Xu JS, Xiu CY, Dong YQ, Zhu X. Variations in energy metabolism along the pericardium meridian and its relationship with visceral function adjustments during electroacupuncture. *BMC Complement Altern Med* 2014;**14**:323.
4. Huang T, Huang X, Zhang W, Jia S, Cheng X, Litscher G. The influence of different acupuncture manipulations on the skin temperature of an acupoint. *Evid Based Complement Alternat Med* 2013;**2013**:905852.
5. Jackson SM, Nesbitt LT. The diagnosis. In: Jackson SM, Nesbitt LT, editors. *Differential diagnosis for the dermatologist*. Berlin: Springer; 2012. p. 785–802.
6. Jernigan DA. *Cancer and low body temperature*. Townsend Letter; 2012. Accessed June 25, 2015, http://www.thefreelibrary.com/Cancer+and+low+body+temperature.-a0307414845.
7. She YF, Zhu J, Ma LX, Xie JP, Li CH, Yuan HW. Analysis on relevance between regional acupoint skin temperature and indoor temperature and humidity in healthy female volunteers during menstruation [in Chinese]. *Zhen Ci Yan Jiu* 2012;**37**:145–50.
8. Fujiwara S, Yoshioka Y, Matsuda T, Nishimoto H, Murakami T, Ogawa A, et al. Brain temperature measured by H-magnetic resonance spectroscopy

in acute and subacute carbon monoxide poisoning. *Neuroradiology* 2016; **58**:27−32.
9. Houdas Y, Ring EFJ. Temperature and humidity measurement; temperature regulation. In: Houdas Y, Ring EFJ, editors. *Human body temperature, its measurement and regulation*. New York: Springer US; 1982. p. 33−5. 105−41.
10. Thies R, Person RJ, Blair RW, Foreman RD. Neurophysiology. In: Thies R, Person RJ, editors. *Physiology*. New York: Springer; 1989. p. 26−71.
11. Farber JP. Pulmonary physiology. In: Person RJ, Thies R, editors. *Physiology*. New York: Springer US; 1989. p. 112−31.
12. Mchale PA, Dormer KJ, Blair RW. Cardiovascular physiology. In: Person RJ, Thies R, editors. *Physiology*. New York: Springer US; 1989. p. 72−111.
13. Beesley RC. Gastrointestinal physiology. In: Person RJ, Thies R, editors. *Physiology*. New York: Springer US; 1989. p. 160−85.
14. Lee MS, Choi TY, Kang JW, Lee BJ, Ernst E. Moxibustion for treating pain: a systematic review. *Am J Chin Med* 2010;**38**:829−38.
15. Lee MS, Choi TY, Park JE, Lee SS, Ernst E. Moxibustion for cancer care: a systematic review and meta-analysis. *BMC Cancer* 2010;**10**:130.
16. Lee MS, Shin BC, Kim JI, Han CH, Ernst E. Moxibustion for stroke rehabilitation: systematic review. *Stroke* 2010;**41**:817−20.
17. Lee DH, Kim JI, Lee MS, Choi TY, Choi SM, Ernst E. Moxibustion for ulcerative colitis: a systematic review and meta-analysis. *BMC Gastroenterol* 2010;**10**:36.
18. Lee MS, Choi TY, Park JE, Ernst E. Effects of moxibustion for constipation treatment: a systematic review of randomized controlled trials. *Chin Med* 2010;**5**:28.
19. Kim JI, Choi JY, Lee H, Lee MS, Ernst E. Moxibustion for hypertension: a systematic review. *BMC Cardiovasc Disord* 2010;**10**:33.
20. Wang P, Zhu J, Xie XL, Sui MH, Zhang QJ, Jia WR, et al. Effects on the tumor specific growth factor and tumor necrosis factor alpha in rats' precancerous lesion of primary hepatocellular carcinoma by direct moxibustion at Ganshu (BL 18) acupoint. *Chin J Integr Med* 2016;**22**:532−6.
21. Shin KR, Ha JY, Park HJ, Heitkemper M. The effect of hand acupuncture therapy and hand moxibustion therapy on premenstrual syndrome among Korean women. *West J Nurs Res* 2009;**31**:171−86.
22. Cai GW, Li J, Xu XJ, Xue YZ, Li G, Wu M, et al. Effect of acupoint heat-sensitive moxibustion intervention on serum osteopontin and matrix metalloproteinase-3 in patients with acute knee pain. *Zhen Ci Yan Jiu* 2013;**38**:488−92 [in Chinese, English abstract].
23. Bin X, Liping J, Si Z, Lan Y, Lijun G, Daoguang L, et al. Skin temperature comparative study on gender differences in twelve meridians Yuan points. *Liaoning Chin Tradit Med J* 2014;**41**:1819−21 [in Chinese, English abstract].
24. Guangjun W, Yuying T, Shuyong J, Tao H, Weibo Z. Change of blood perfusion in Hegu acupoint after contralateral Hegu acupoint was stimulated. *J Altern Complement Med* 2012;**18**:784−8.
25. Zhou S, Huang LP, Liu J, Yu JH, Tian Q, Cao LJ. Bilateral effects of 6 weeks' unilateral acupuncture and electroacupuncture on ankle dorsiflexors muscle strength: a pilot study. *Arch Phys Med Rehabil* 2012;**93**:50−5.
26. De Souza LL, De Araujo FL, Da Silva FA, Mucciaroni TS, De Araujo JE. Unilateral and immediate stimulation of acupuncture points Xiaohai (SI8) and Jianwaishu (SI14) of the small intestine meridian increases electromyographic activity and strength in the ipsilateral and contralateral upper trapezius muscle. *J Acupunct Meridian Stud* 2016;**9**:250−6.
27. Gao H, Li X, Gao X, Ma B. Contralateral needling at unblocked collaterals for hemiplegia following acute ischemic stroke. *Neural Regen Res* 2013;**8**:2914−22.
28. Yang EJ, Koo ST, Kim YS, Lee JE, Hwang HS, Lee MS, et al. Contralateral electroacupuncture pretreatment suppresses carrageenan-induced inflammatory pain via the opioid-mu receptor. *Rheumatol Int* 2011;**31**:725−30.
29. Liu H, Xu JY, Li L, Shan BC, Nie BB, Xue JQ. FMRI evidence of acupoints specificity in two adjacent acupoints. *Evid Based Complement Alternat Med* 2013;**2013**:932581.
30. Wong YM. Preliminary investigation: acupoint-skin conductance in stroke survivors. *Appl Psychophysiol Biofeedback* 2014;**39**:159−62.
31. Macpherson H, Tilbrook H, Richmond S, Woodman J, Ballard K, Atkin K, et al. Alexander technique lessons or acupuncture sessions for persons with chronic neck pain: a randomized trial. *Ann Intern Med* 2015;**163**:653−62.
32. Cherkin DC, Sherman KJ, Avins AL, Erro JH, Ichikawa L, Barlow WE, et al. A randomized trial comparing acupuncture, simulated acupuncture, and usual care for chronic low back pain. *Arch Intern Med* 2009;**169**:858−66.
33. Pfister DG, Cassileth BR, Deng GE, Yeung KS, Lee JS, Garrity D, et al. Acupuncture for pain and dysfunction after neck dissection: results of a randomized controlled trial. *J Clin Oncol* 2010;**28**:2565−70.
34. Bahrami-Taghanaki H, Liu Y, Azizi H, Khorsand A, Esmaily H, Bahrami A, et al. A randomized, controlled trial of acupuncture for chronic low-back pain. *Altern Ther Health Med* 2014;**20**:13−9.
35. Zheng H, Li Y, Chen M. Evidence based acupuncture practice recommendations for peripheral facial paralysis. *Am J Chin Med* 2009;**37**:35−43.
36. Chen R, Chen M, Kang M, Xiong J, Chi Z, Zhang B, et al. The design and protocol of heat-sensitive moxibustion for knee osteoarthritis: a multicenter randomized controlled trial on the rules of selecting moxibustion location. *BMC Complement Altern Med* 2010;**10**:32.
37. Chiu HY, Hsieh YJ, Tsai PS. Acupuncture to reduce sleep disturbances in perimenopausal and postmenopausal women: a systematic review and meta-analysis. *Obstet Gynecol* 2016;**127**:507−15.
38. Molassiotis A, Bardy J, Finnegan-John J, Mackereth P, Ryder DW, Filshie J, et al. Acupuncture for cancer-related fatigue in patients with breast cancer: a pragmatic randomized controlled trial. *J Clin Oncol* 2012;**30**:4470−6.
39. Meng Z, Kay Garcia M, Hu C, Chiang J, Chambers M, Rosenthal DI, et al. Sham-controlled, randomised, feasibility trial of acupuncture for prevention of radiation-induced xerostomia among patients with nasopharyngeal carcinoma. *Eur J Cancer* 2012;**48**:1692−9.
40. Deng G, Chan Y, Sjoberg D, Vickers A, Yeung KS, Kris M, et al. Acupuncture for the treatment of post-chemotherapy chronic fatigue: a randomized, blinded, sham-controlled trial. *Support Care Cancer* 2013;**21**:1735−41.
41. Raith W, Litscher G, Sapetschnig I, Bauchinger S, Ziehenberger E, Muller W, et al. Thermographical measuring of the skin temperature using laser needle acupuncture in preterm neonates. *Evid Based Complement Alternat Med* 2012;**2012**:614210.
42. Hsiu H, Hsu WC, Hsu CL, Bau JG, Chen CT, Liu YS. Complexity analysis of the microcirculatory-blood-flow response following acupuncture stimulation. *Microvasc Res* 2013;**89**:34−9.