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# Research on the Cooling Garment Based on Acupoints Cold Stimulation under a High-Temperature Environment

*When the human body experiences heat stress beyond the normal range, it may affect health and work efficiency to a certain extent. This study aimed to investigate the effectiveness of cold stimulation on Dazhui point (GV14), bilateral Xinshu points (B15), bilateral Danshu points (B19), and bilateral Quchi points (LI11) in the body to relieve heat strain in a high-temperature environment. The experiment results showed that the skin temperature ($T_{skin}$), tympanic temperature ($T_{ty}$), heart rate (HR), the physiological strain index based on heart rate ($PSI_{HR}$), thermal sensation (TS), and thermal comfort (TC) of the participants with acupoints cold stimulation were better than those without acupoints cold stimulation ($p < 0.05$). $T_{skin}$ decreased by an average of 0.04 ± 0.46℃. $T_{ty}$ decreased by an average of 0.08 ± 0.21℃. The study concluded that cold stimulation at acupoints could reduce the heat strain and improve the thermal comfort of the human body.*

**Keywords:** *thermal protection, heat strain, thermal sensation, human thermal comfort*

## 1. INTRODUCTION

In sectors such as mining operations, firefighting, and outdoor work during the summer, cooling garments are commonly utilized to enhance work efficiency and safeguard the health of personnel [1]. The rationale for employing cooling garments lies in their ability to create a comfortable microclimate with reduced energy expenditure compared to air conditioning systems. In contrast, air conditioning systems not only consume greater amounts of energy but also exhibit energy consumption that is influenced by operational duration and ventilation [2]. Due to the thermal performance enhancement capabilities of phase change materials and nanofluids [3-4], leveraging these two materials has become a trend in the advancement of cooling garment performance.

At present, cooling garments mostly enhance human body heat dissipation in two ways. One is increasing the cooling area of the human body, such as increasing the length of the clothing cooling pipeline, increasing the number of cooling ice packs or increasing the flow of gas convection area. The other is to strengthen the cooling area of the human body with high-heat dissipation efficiency, such as increasing the head, neck area, and torso area of the human body [5]. These two methods have significant drawbacks; for instance, increasing the cooling surface area leads to an increase in the weight of the cooling garment and a concomitant rise in cooling energy loss. Additionally, cooling specific areas such as the head and neck in construction sites or industrial areas may compromise head protection. Traditional Chinese medicine has unique methods for cooling the human body. For example, there is an acupoint stimulation. In research on the effectiveness of acupoint stimulation, both domestic and international researchers and organizations have reported progress in studies involving both animals and humans. In the aspect of animals, it was found that acupoint stimulation played an anti-inflammatory effect in mice [6], relieved pain in mice [7], and improved neurological function in stroke rats [8]. In addition, it was proved that acupuncture stimulation caused temperature changes in horse body surface, promoted muscle relaxation, and interfered positively with animals' well-being [9]. In the aspect of humans, acupoint stimulation could affect skin temperature near the stimulated acupoints and alter local blood flow [10-11]. As can be seen, animal and human acupoint stimulation studies show that there is indeed a certain relationship between acupoint stimulation and the functional regulation of the body. In particular, there is much research on relieving heat strain or cooling the human body by stimulating relevant acupoints over China. It was proved efficient even in animals [12]. There are many methods of acupoint stimulation in the human body, including local injection [13], acupuncture [14], massage [15], cupping [16], scraping [17], drug acupoint application [18], drug sponge bath [19], moxibustion [20]. Among the above treatment methods, the ice-moxibustion therapy proposed by Zhao [21] attracted attention. For the treatment, pure water, ionized water, or concentrated concoction of traditional Chinese medicine is made as an icicle with a diameter of about 2 cm, and the round surface of the icicle is placed on the symptomatic acupoints. Acupoints can be stimulated by ice moxibustion. Moreover, the heat accumulated in the human body could be absorbed by the icicle.

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This study proposed a method of cooling the body by cold stimulation of acupoints to relieve the heat strain and improve the comfort of the human body. According to the theory of traditional Chinese medicine, the corresponding acupoints were selected, and an acu–points cooling vest was designed. Through the analysis and discussion of the experiment results, the feasibility, effectiveness, and comfort of the acupoints cold sti–mulation were verified. The vest is deployable for people engaged in low-metabolic activities such as traffic directing, security guarding, medical sampling, and fishing in high-temperature environments. This cooling vest is capable of reducing human body tempe–rature and alleviating thermal stress.

## 2. METHODS

### 2.1 Acupoints selection

According to the traditional Chinese medicine theory and the research [13-14,18], GV14, bilateral B19, and bilateral LI11 were selected. Since the human is in a hot environment for a long time, the heart rate usually increases, causing problems such as accelerated heart beat [22]. Therefore, bilateral B15 are added to relieve the symptoms of arrhythmia caused by high tempe–rature, and improve the comfort of the human body.

### 2.2 Acupoints cooling equipment

The acupoints cooling vest is used to cool the acupoints of the human body. The vest is composed of five semiconductor air-cooled refrigerators as refrigeration units. The structure of the refrigerator is illustrated, as shown in Figure 1.

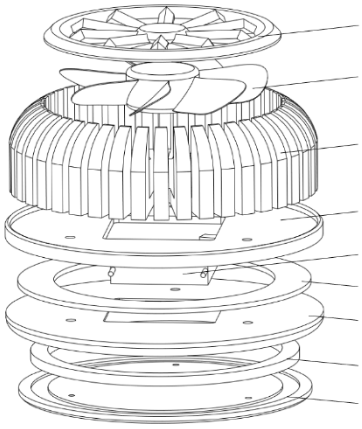


**Figure 1. Schematic diagram of the structure of the refrigerator**

The thermoelectric cooler (TEC) was taken as the critical part of the air-cooled refrigerator. The TEC's model number is TEC1-07102 (Jiangsu Xinghe Elec–tronic Technology Co., Ltd, Jiangsu, CHN). The hot side of the TEC is cooled by forced air through a heat sink and a fan, and a cooler sheet conducts the cold side. A printed circuit board (PCB) is used to integrate the fan and TEC power supply circuit. There is a magnetic ring between the lower base of the air-cooled refrige–rator and the cooler sheet, and the refrigerator is adsorbed on the vest with a steel plate through the magnetic ring. The diameter of the steel plate on the vest is Ø70 mm, and the five refrigerators are powered by the flexible printed circuit (FPC) in parallel. The other two refrigerators are directly tied to the bilateral LI11 of the human body through elastic rubber bands in parallel. The total rated cooling power of the 7 refrigerators is 49 W. The weight of a single refrigerator is 95 g, and the weight of the acupoints cooling vest is 1.1 kg. The acupoints cooling vest is shown in Figure 2.

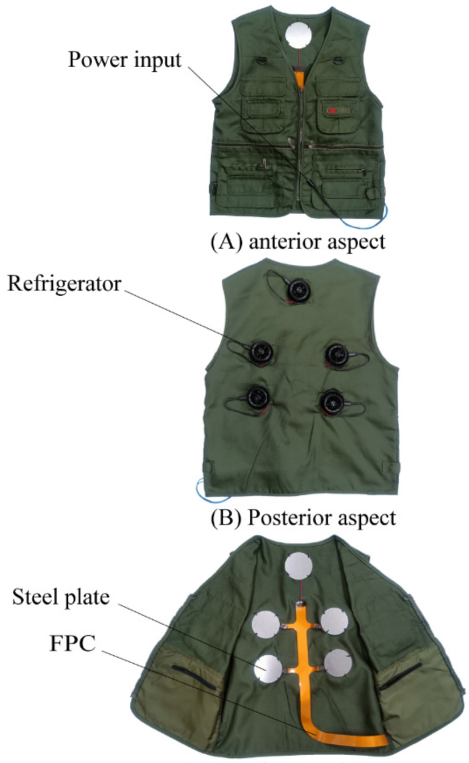


**Figure 2. The acupoints cooling vest**

### 2.3 Thermal balance analysis

The body's heat storage without the acupoints cooling vest can be written as:

$$Q_s = \left(Q_m - Q_W\right) - \left(Q_{conv} + Q_{cond} + Q_r + Q_{eva} + Q_{res}\right) \quad (1)$$

In this equation, $Q_s$ represents the heat storage of the body, $Q_m$ denotes the metabolic heat production, $Q_w$ refers to the effective mechanical power, Qconv acco–unts for the heat losses is the heat loss due to con–vection, $Q_{cond}$ (conduction), $Q_r$ (radiation), $Q_{eva}$ (sweat evaporation), $Q_{res}$ (respiration).

In most situations, the effective mechanical work power is small and can be neglected [23]. The heat loss due to respiration is less than 5%, and the heat loss due to conduction is less than 1% in most cases [24]. The–refore, these two heat losses can be neglected. Because of the cooling vest, the human body sweats less. In addition, the evaporation of sweat is limited owing to the cooling vest. Thus, the heat loss due to sweat evaporation can be neglected. This experiment was carried out at an ambient temperature of 40°C. Since the ambient temperature is higher than the human skin temperature, the direction of heat transfer is from the environment to the human body. In the case of wearing the acupoints cooling vest, the body dissipates heat through 7 refrigerators.

To simplify the heat transfer model, the following assumptions are made:

(a) The temperature of the skin equals the temperature of the clothes. (b) The surface of the skin and the clothes is treated as a plane. (c) The heat transfer of all objects is even.

Hence, the heat storage with an acupoints cooling vest can be simplified as:

$$Q_s = (Q_m + Q_{conv} + Q_r) - Q_{acu} \tag{2}$$

where $Q_{acu}$ is the heat loss due to the acupoints cooling vest.

According to ISO 8996:2021 [23], $Q_m$ can be expressed by heart rate:

$$Q_m = M_0 + (HR - HR_0) / RM \tag{3}$$

where $M_0$ denotes the resting metabolic rate, $HR$ represents the heart rate, $HR_0$ is the resting heart rate, and $RM$ refers to the increase in heart rate per unit of metabolic rate.

$RM$ can be expressed as:

$$RM = (HR_{\max} - HR_0) / (MWC - M_0) \tag{4}$$

where $HR_{\max}$ is the maximum heart rate, $MWC$ is the maximum working capacity.

$$MWC = (19.45 - 0.133 \bullet Age) \bullet W_{bl} \tag{5}$$

where $Age$ is the age of the subject, $W_{bl}$ is the lean body mass.

The heat loss due to convection can be written as:

$$Q_{conv} = h_c f_{cl} (T_a - T_{cl}) A_{cl} \tag{6}$$

where $h_c$ represents the convective heat transfer coefficient, $f_{cl}$ is the clothing area factor, $T_{cl}$ denotes the temperature of the garment, $T_a$ signifies the temperature of the environment, and $A_{cl}$ refers to the effective cooling area.

Because the wind speed of the ambient environment is less than 0.1 m/s, there is natural convection between the human body and the environment. The natural convection heat transfer coefficient $h_c$ can be expressed as [25]:

$$h_c = 2.38 |T_{cl} - T_a|^{0.25} \tag{7}$$

where the ratio of the subject's clothed to unclothed surface areas, $f_{cl}$, is given by [25]:

$$f_{cl} = 1 + 1.97 I_{cl} \tag{8}$$

where $I_{cl}$ is the basic heat exchange resistance of the garment, in this study, the value of $I_{cl}$ is 0.6 clo [25].

The heat loss due to radiation can be expressed by the equation:

$$Q_r = h_r f_{cl} (T_r - T_{cl}) A_{cl} \tag{9}$$

$h_r$ can be expressed as [25]:

$$h_r = 5.67 \times 10^{-8} \varepsilon f_{eff} \frac{(T_{cl} + 273)^4 - (T_r + 273)^4}{|T_{cl} - T_r|} \tag{10}$$

where $\varepsilon$ denotes the emissivity of the outer surface of the cooling garment, $f_{eff}$ is the effective radiation area factor of the cooling garment ($f_{eff}$ = 0.77), $T_r$ refers to the radiant temperature of the environment. In this study, the value of $h_r$ is estimated as 4.3 [W/(m$^2$·K)] [26].

In this study, the heat loss due to the acupoints cooling vest can be expressed as:

$$Q_{acu} = n[\alpha I T_c - \frac{1}{2} I^2 R - K(T_h - T_c)] A_s \tag{11}$$

In this equation, $n$ represents the number of TEC thermocouples, $\alpha$ is the Seebeck coefficient, $I$ denotes the input current, $R$ is the electrical resistance of TEC, $K$ is the thermal conductivity, $T_c$ and $T_h$ represent the cold-side and hot-side temperatures of the TEC, respectively, and $A_s$ is the effective cooling area of the refrigerator. In this study, the heat loss due to the acupoints cooling vest is 49 W.

Replacing the (3), (6), (9), and (11) into (2), it can be expressed as:

$$\begin{aligned} Q_s = {} & [M_0 + (HR - HR_0) / RM + h_c f_{cl} (T_a - T_{cl}) A_{cl} + \\ & h_r f_{cl} (T_r - T_{cl}) A_{cl}] - n[\alpha I T_c - \frac{1}{2} I^2 R - K(T_h - T_c)] A_s \end{aligned} \tag{12}$$

When body heat storage $Q_s$ = 0, the human body is in thermal balance, and the body reaches the best thermal comfort state. According to ISO 8996:2021 [23], under the condition of low metabolism, the range of metabolic rates is 125 W to 235 W. It can be concluded that even if air-cooled refrigerators are used, it is impossible for the body to reach a complete thermal balance. Therefore, the cold stimulation of the acupoints on the human body is aimed at improving the thermal comfort of the human body rather than making the subject thermal balance completely.

## 3. EXPERIMENTAL

### 3.1 Participants

Three healthy male college students participated in the test (25 ± 3 years old, weighed 71.6 ± 2.7 kg, body mass index = 24.0 ± 0.6). Before the test, all participants were trained in the test process and informed about the precautions of the test process. During the test, if the participant felt unwell, the test was terminated immediately.

### 3.2 Experimental procedures

The test was carried out in a climate chamber. The temperature of the climate chamber was 40 ± 1°C, 39 ± 3% RH, and the wind speed was lower than 0.1 m/s. Each subject participated in the tests twice in the chamber. There were in the 40°C without acupoints cold stimulation (CON) in the 40°C with acupoints cold stimulation (ACS), respectively. The test time was set according to GB/T 4200-2008 [27] and was expected to be 40 min for CON and ACS. Before the next round of testing, the same subjects relaxed at least two hours after the end of each test. All subjects have adequate sleep and avoid alcohol consumption before the test. During the test, if the tympanic temperature exceeds 39 °C or the heart rate exceeds 160 bpm, the test is stopped immediately.

Subjects rested for 15 minutes in an indoor envi–ronment with a temperature of 28℃ and 52% RH after arriving at the test place. All test subjects wore the same cotton short-sleeved T-shirt (100% cotton) and loose trousers (96.3% cotton and 3.7% spandex); subjects drank 200 mL of water and urinated completely before the test. With the help of the staff, the temperature sen–sor and the heart rate sensor were fixed on the subjects. Each subject was expected to be tested by a standard standing posture for 40 min for CON and ACS, respec–tively. Data monitoring continued during the whole expe–riment.

### 3.3 Measurement item

The $T_{skin}$ was measured continuously using a data logger (TYHC XSL/A-RS1P0V0, Beijing, CHN) at 1-min in–tervals. According to ISO 9886:2004 [28], the neck temperature ($T_{neck}$), right scapula temperature ($T_{Rsca}$), left-hand temperature ($T_{Lhand}$), and right shin tempe–rature ($T_{Rshin}$) were selected to calculate the $T_{skin}$. The $T_{skin}$ was calculated using the following equation:

$$T_{skin} = 0.28T_{neck} + 0.28T_{Rsca} + 0.16T_{Lhand} + 0.28T_{Rshin} \quad (13)$$

The change in $T_{skin}$ in 40℃ ($\Delta T_{skin}$) was calculated by subtracting the average $T_{skin}$ in the CON group from the average $T_{skin}$ in the ACS group. The tympanic temperature ($T_{ty}$) was measured using an infrared data logger (Yuwell YHT101, Jiangsu, CHN) at 1-min inter–vals. The change in $T_{ty}$ in 40℃ ($\Delta T_{ty}$) was calculated by subtracting the average $T_{ty}$ in the CON group from the average $T_{ty}$ in the ACS group. The heart rate (*HR*) was measured using a comprehensive para–meter data log–ger (Scchengyi XY-2 type, Sichuan, CHN). The *HR* was recorded every 1 minute. The chan–ge in *HR* at 40℃ ($\Delta HR$) was calculated by subtracting the average *HR* in the CON group from the average *HR* in the ACS group. According to GB/T 18977-2003 [29], the rating of thermal sensation (*TS*, via a 9-point scale ranging from very cold -4 to very hot +4) and thermal comfort (*TC*, via a 5-point scale rating from comfortable 0 to extre–mely uncomfortable 4) were recorded every 5 minutes by questionnaires. In order to objectively evaluate hu–man heat stress, the physiological strain index const–ructed from heart rate ($PSI_{HR}$) was used to represent the metabolic rate and the strain reflected by the cardio–vascular system. $PSI_{HR}$ categorizes the strain between 0 and 5; the higher the value, the higher the strain [30].

$$PSI_{HR} = \frac{5(HR - HR_0)}{180 - HR_0} \quad (14)$$

### 3.4 Statistical analyses

All data are expressed as mean ± standard deviation (SD). Statistical analysis was performed using paired Student's t-tests for the data. Where applicable, the mean difference (MD) and 95% confidence interval (CI) are reported. For all comparisons, significance was set at $p < 0.05$.

## 4. RESULTS

Comparison results of human physiological parameters at an ambient temperature of 40 °C are shown in Figure 3. $T_{skin}$ in the ACS group was higher than that in the CON group during the first 13 minutes. From the 14th min to the end of the test, $T_{skin}$ in the ACS group was lower than that in the CON group. $\Delta T_{skin}$ decreased by an average of 0.04 ± 0.46℃, 95% CI [-0.12, -0.04], p = 0.363. $T_{ty}$ in the ACS group was significantly lower than that in the CON group ($p < 0.01$). $\Delta T_{ty}$ decreased by an average of 0.08 ± 0.21℃ , 95% CI [-0.12, -0.04], $p < 0.01$. *HR* in the ACS group was significantly lower than that in the CON group ($p < 0.01$). $PSI_{HR}$ in the ACS group was lower than that in the CON group ($p < 0.01$). *TS* in the ACS group was better than that in the CON group during the first 25 minutes, and from the 25th minute to the end of the test, *TS* in the ACS group was almost the same as that in the CON group. *TC* in the ACS group was better than that in the CON group ($p < 0.01$).

## 5. DISCUSSION

In previous studies [1], the main types of personal cooling systems focused on air-cooled garments (ACG), liquid cooling garments (LCG), and phase change gar–ments (PCG). The acupoints cooling vest combines the advantages of the ACG, LCG, and PCG. The system is simpler than the LCG, and it does not need to be cooled regularly like the PCG. The cold surface temperature is also lower than the outlet airflow temperature of fans, and it only needs to provide enough power to work.

In previous studies, Ernst and Garimella [31] developed a compressor LCG system that could provide 100 - 300 W of cooling capacity in a 37.7 - 47.5 °C environment. It could work continuously for 5.7 hours with a cooling capacity of 178 W at 43.3 °C. Song and Li [32] designed an LCG device using vapor compre–ssion refrigeration. The rated cooling capacity of the device is 180 W at an ambient temperature of 43 °C. Chen et al. [33] designed an LCG that relied on ice to provide a cooling source. The heat dissipation of LCG is 115.17 W. It basically meets the thermal comfort of low or medium metabolic rate work. According to ISO 8996:2021 [23], the range of low metabolic rate is 125 W to 235W, and the range of medium metabolic rate is 235 W to 360 W. If the body is to be fully thermal comfortable in a medium metabolic rate, the cooling power needs to be at least 235 W. However, the con–sequence of high cooling capacity is that the weight and volume of the refrigeration equipment will increase accordingly. It would cause other problems, such as the large size of the equipment, inconvenience to carry, and bulky equipment that is not suitable for personnel to wear. Therefore, the use of thermal protective equip–ment mostly focuses on improving thermal comfort and work efficiency rather than completely meeting the thermal comfort of personnel.

In previous studies [5], the head, neck, and torso provided the highest heat removal efficiency. The main reasons for the high cooling efficiency of the head and neck are attributed to the extensive and superficial vascular distribution. Besides, a large amount of body heat can be taken away by the rapid blood flow of the large blood vessels on both sides of the neck. The advantage of cooling the torso is ascribed to a larger bo-

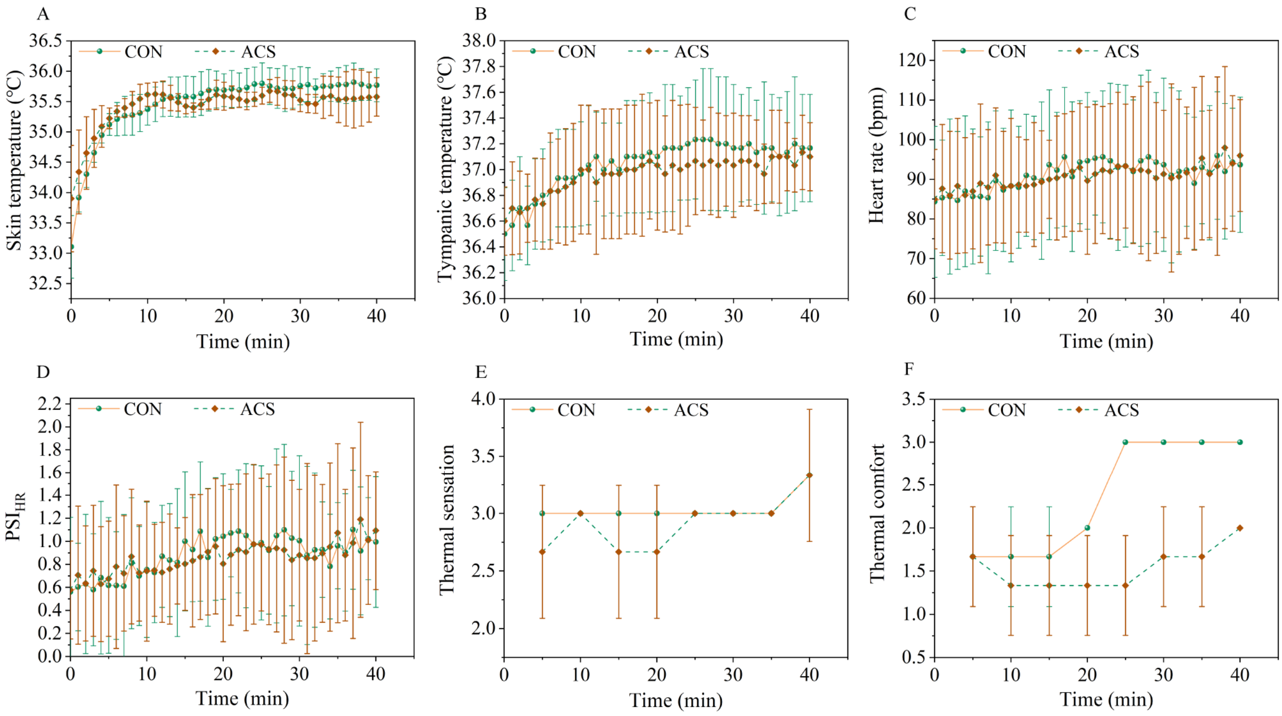


**Figure 3. Comparison results of physiological parameters at an ambient temperature of 40℃**

dy surface area while cooling the precordial region. In addition to directly reducing the heat load of the heart, it can also significantly and effectively cool the circu–lating blood volume in the body through conduction and convection. Thereby, the body core temperature is reduced [22]. Acupoints are unique points in the theory of traditional Chinese medicine, and they are mostly places with many nerve endings and blood vessels. Luo and Xu [34] concluded that the temperature distribution of acupoints in the human body shows a centripetal increasing trend. The closer to the head and face, the higher the temperature value. This is echoed by cooling the head and neck to improve the cooling efficiency of the human body. Feng and Zhang [35] reviewed the specificity of heat conduction along the meridian lines using infrared technology. It suggested that the human meridians could be good channels for heat. B15 and B19 have the effect of relieving heat in traditional Chi–nese medicine theory, and these two acupoints are located on the back of the human torso. Cooling B15 and B19 may benefit the heat dissipating along the meridians.

In terms of the mechanism of body temperature regulation in a hot environment, endocrine glands, skeletal muscles, skin blood vessels, and sweat glands are changed by the activity of the thermotaxic center. Therefore, the heat production and dissipation of the body are adjusting correspondingly. Thermoreceptors are classified into peripheral thermoreceptors and cent–ral thermoreceptors according to the distribution posi–tions. In the superficial layer of the skin, peripheral thermoreceptors are punctately distributed. When receptors receive hot and cold stimuli, cold and thermal receptors and pulse signals are emitted. The central thermoreceptor directly senses the temperature change of blood flowing through the brain and spinal cord and transmits the pulse to the hypothalamus thermotaxic center through nerves [36]. GV14 is located in the depression under the spinous process of the vertebra prominens. It coincides with the position of the human spinal cord and has the effect of curing fever. The cooling of GV14, bilateral B15, and B19 might affect the thermoreceptors, thereby improving the *TS* and *TC* of the human body.

## 6. CONCLUSIONS

In this study, GV14, bilateral B15, bilateral B19, and bilateral LI11 of the human body were locally cooled by the semiconductor air-cooled refrigerators with a rated cooling power of 49 W. Three healthy male subjects were tested in the environment of 40 ± 1℃, 39 ± 3% RH. The skin temperature with acupoints cold stimu–lation was lower than that without acupoints cold stimu–lation ($p < 0.05$). The tympanic temperature with ACS only decreased by an average of 0.08 ℃ than that with CON ($p < 0.05$). $PSI_{HR}$ with ACS decreased by an average of 0.42 than that with CON ($p < 0.05$). Thermal sensation and thermal comfort with acupoints cold sti–mulation were better than that without acupoints cold stimulation ($p < 0.05$). The results showed the effecti–veness of cold stimulation for acupoints. The next step will be to improve the semiconductor air-cooled refri–gerator and explore the optimal cooling temperature of acupoints for the human body.

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## NOMENCLATURE

| | |
|---|---|
| GV14 | Dazhui point |
| B15 | Xinshu point |
| B19 | Danshu point |
| LI11 | Quchi point |
| TEC | Thermoelectric cooler |
| PCB | Printed circuit board |
| FPC | Flexible printed circuit |
| SD | Standard deviation |
| MD | Mean difference |
| CI | Confidence interval |
| $T_{skin}$ | Skin temperature [°C] |
| $T_{ty}$ | Tympanic temperature [°C] |
| $HR$ | Heart rate [bpm] |
| $PSI_{HR}$ | The physiological strain index based on heart rate |
| $TS$ | Thermal sensation |
| $TC$ | Thermal comfort |
| $Q_s$ | Heat storage of the body [W] |
| $Q_m$ | Metabolic heat production [W] |
| $Q_w$ | Mechanical work power [W] |
| $Q_{conv}$ | Heat loss due to convection [W] |
| $Q_{cond}$ | Heat loss due to conduction [W] |
| $Q_r$ | Heat loss due to radiation [W] |
| $Q_{res}$ | Heat loss due to respiration [W] |
| $Q_{eva}$ | Heat loss due to sweat evaporation [W] |
| $M_0$ | The resting metabolic rate [W] |
| $Q_{acu}$ | Heat loss due to the cooling vest [W] |
| $HR_0$ | The resting heart rate [bpm] |
| $RM$ | The increase in heart rate per unit of metabolic rate |
| $HR_{\max}$ | The maximum heart rate [bpm] |
| $MWC$ | The maximum working capacity [W] |
| $Age$ | The age of the subject [year] |
| $W_{bl}$ | The lean body mass [kg] |
| $h_c$ | Convective heat transfer coefficient [W/(m$^2$·K)] |
| $f_{cl}$ | Clothing area factor [m$^2$/m$^2$] |
| $T_a$ | Temperature of the environment [°C] |
| $T_{cl}$ | Temperature of the garment [°C] |
| $A_{cl}$ | Effective cooling area [m$^2$] |
| $I_{cl}$ | The basic heat exchange resistance of garment [clo] |
| $h_r$ | Radiation heat transfer coefficient [W/(m$^2$·K)] |
| $T_r$ | Radiant temperature of the environment [°C] |
| $\varepsilon$ | The emissivity of the outer surface of the cooling garment |
| $f_{eff}$ | Effective radiation area factor of the cooling garment |
| $n$ | The number of TEC thermocouples |
| $\alpha$ | The Seebeck coefficient [V/K] |
| $I$ | The input current [A] |
| $R$ | The electrical resistance of TEC [Ω] |
| $K$ | Thermal conductivity [W/(m·K)] |
| $T_h$ | TEC hot-side temperature [°C] |
| $T_c$ | TEC cold-side temperature [°C] |
| $A_s$ | Effective cooling area of the refrigerator [m$^2$] |
| $T_{neck}$ | Neck temperature [°C] |
| $T_{Rsca}$ | Right scapula temperature [°C] |
| $T_{Lhand}$ | Left hand temperature [°C] |
| $T_{Rshin}$ | Right shin temperature [°C] |
| $\Delta T_{skin}$ | The change in $T_{skin}$ [°C] |
| $\Delta T_{ty}$ | The change in $T_{ty}$ [°C] |
| $\Delta HR$ | The change in $HR$ [bpm] |

## ИСТРАЖИВАЊЕ ОДЕЋЕ ЗА ХЛАЂЕЊЕ ЗАСНОВАНО НА СТИМУЛАЦИЈИ ХЛАДНОЋЕ АКУПУНКТУРНИХ ТАЧАКА У ОКРУЖЕЊУ ВИСОКЕ ТЕМПЕРАТУРЕ

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Када људско тело доживи топлотни стрес изван нормалног опсега, то може утицати на здравље и радну ефикасност у одређеној мери. Ова студија је имала за циљ да истражи ефикасност стимулације

хладноћом на тачки Дажуи (ГВ14), билатералним Ксиншу тачкама (B15), билатералним Дансху тач–кама (B19) и билатералним Кучи тачкама (LI11) у телу како би се ублажио топлотни напор на високој температури. Животна средина. Резултати експе–римента су показали да су температура коже ($T_{skin}$), температура бубњића ($T_{ti}$), откуцаји срца (HR), индекс физиолошког напрезања заснован на пулсу (PSIHR), топлотни осећај (TS) и топлотни комфор (TC) учесници са хладном стимулацијом акупун–ктурних тачака били су бољи од оних без стиму–лације хладном акупунктуром ($p < 0,05$). Тскин се смањио у рросеку за 0,04 ± 0,46 ℃. Тти се смањио у рросеку за 0,08 ± 0,21 ℃. Студија је закључила да стимулација хладноћом у акурунктурним тачкама може смањити торлотни нарор и робољшати торлотни комфор људског тела.