



RESEARCH ARTICLE

A Pilot Study Exploring the Effects of Reflexology on Cold Intolerance

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Abstract

Cold intolerance is an inability to tolerate cold temperatures and is accompanied by symptoms including headache, shoulder discomfort, dizziness and palpitations. The current study was performed to examine whether reflexology therapy affected cold intolerance in human subjects and whether the treatment was systemically effective. Ten female volunteer examinees with subjective feelings of cold were examined. After a 5-minute foot bath, 10 minutes of reflexology therapy was performed on their left foot. Skin temperature and blood flow were estimated before and after treatment, together with an interview concerning their feelings of cold and daily habits. In addition, how the recovery rate was affected by the application of a chilled-water load was also estimated. Along with significant increases in skin temperature and blood flow compared with pre-treatment at the bilateral points of KI-1, LR-3, and BL-60, a faster recovery after the application of the chilled-water load was also seen in the lower limbs on both sides. From these results, we conclude that reflexology has systemic effects and is an alternative method for treating cold intolerance.

1. Introduction

Cold intolerance is the inability to tolerate cold temperatures. In recent years, it has been reported that from one third to one half of women in Japan suffer from cold intolerance [1]. Although many women suffer vexing symptoms, in general, it is not considered to be a condition that requires diagnosis and treatment by a medical professional. It is much more common in women undergoing menopause. In addition, cold limbs, a cold body, difficulty in sleeping and other symptoms such as headache, shoulder stiffness, backache, dizziness and palpitations often

accompany cold intolerance and may interfere with activities of daily living and quality of life [1].

In reflexology, the foot is considered to be representative of the rest of the body. Reflexology, also called zone therapy, is an alternative treatment method involving the practice of massaging, squeezing or pushing on parts of the feet, and sometimes the hands and ears, with the goal of inducing a beneficial effect on other parts of the body. It is very popular in the high-stress society of Japan and is widely used to reduce tension, induce recovery from fatigue, and to refresh the mind and body. Reflexology is said to be effective at promoting blood circulation, but

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at present, there is little scientific evidence that it improves blood flow in people who suffer from sensitivity to cold temperatures. Hence, it is necessary to conduct a study into its effects. In general, most cold intolerance is considered to be caused by circulatory disorders of the blood and lymph fluid [2]. According to reflexology theory, areas of the foot correspond to areas of the body. In contrast, the Traditional Chinese Medicine (TCM) view is that the spleen is considered to affect the limbs, and cold intolerance is mostly attributed to Yang-deficiencies of both the spleen and kidney. It is also said that “spleen deficiencies and cold syndrome exist simultaneously”. In this pilot study, in addition to a discussion as to whether reflexology is effective at improving the blood circulation of the lower limbs, we also estimate whether reflexology has general effects on cold intolerance by comparing the changes in the treated foot and the untreated foot in each person.

2. Materials and Methods

2.1. Subjects

As women are most commonly affected, 10 females were recruited in our study as a basis for assessing the subjective symptoms of cold limbs, especially cold feet. During 20 minutes of acclimatization in the experimental laboratory at a room temperature of $25 \pm 1^\circ\text{C}$, body weight, body fat percentage, body moisture percentage, muscle percentage and basal metabolic rate were measured using a Body Composition Health Meter (AITEC Tokyo, Japan). A questionnaire mainly including questions regarding lifestyle, fitness habits, chilled sites, and menstruation was administered (Table 1).

2.2. Study design and methods

According to reflexology, invisible waste material accumulates in the foot. To remove this invisible waste material, 5 minutes of foot bathing at a temperature of 40°C was initially performed (Figure 1A). After that, the wards of the sole, instep, and the lateral aspects of the left foot were stimulated five times each for a total of 10 minutes with a moderate strength using digital joints or finger pressure (Figure 1B). For comparison, the opposite foot was left untreated.

Figure 2 shows the experimental process of our study. Instant skin temperature was measured at points LR-3 (*Taichong*), KI-3 (*Taixi*), BL-60 (*Kunlun*), and KI-1 (*Yongquan*) with a thermometer (ST-717; Scalar, Tokyo, Japan). About 30 seconds of blood flow in a stable condition was recorded with a laser blood flow meter (Cyber Med CDF-2000; OAS Co. Ltd., Tokyo, Japan) and a fixed sensor placed on the back of the third toe. The mean for the time period was then calculated. In order to estimate the recovery from the chilled condition after treatment, both feet were immersed into a water bath

Table 1 General interview sheet

Questionnaire items ($n=10$)

Chilled region (upper limb, lower limb, waist, others)
 Smoker (Y, N), Drinker (Y, N)
 Nutrient intake [times of meals, content (cereal or protein)]
 Physical activity, movement (Y, N)
 Menstrual cycle disorder, accompanying cramp
 Condition of the lower back and limbs (weakness or swelling)

Y=yes; N=no.

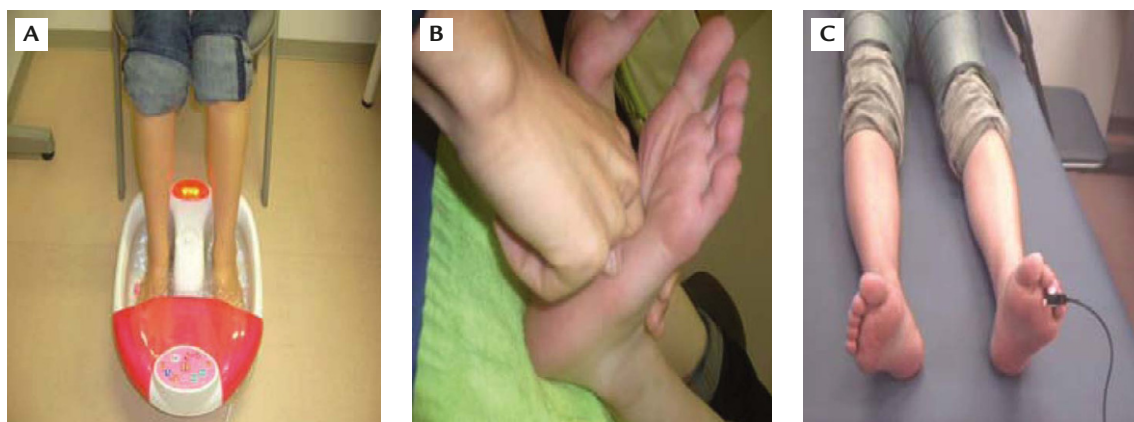


Figure 1 Photographs of footbath, reflexology therapy and blood flow measurement. (A) A water bath maintained at 4°C . (B) Reflexology therapy administered to the plantar reflection wards of the left foot using a finger joint. (C) Measurement of blood flow with a fixed sensor placed on the back of the third toe.

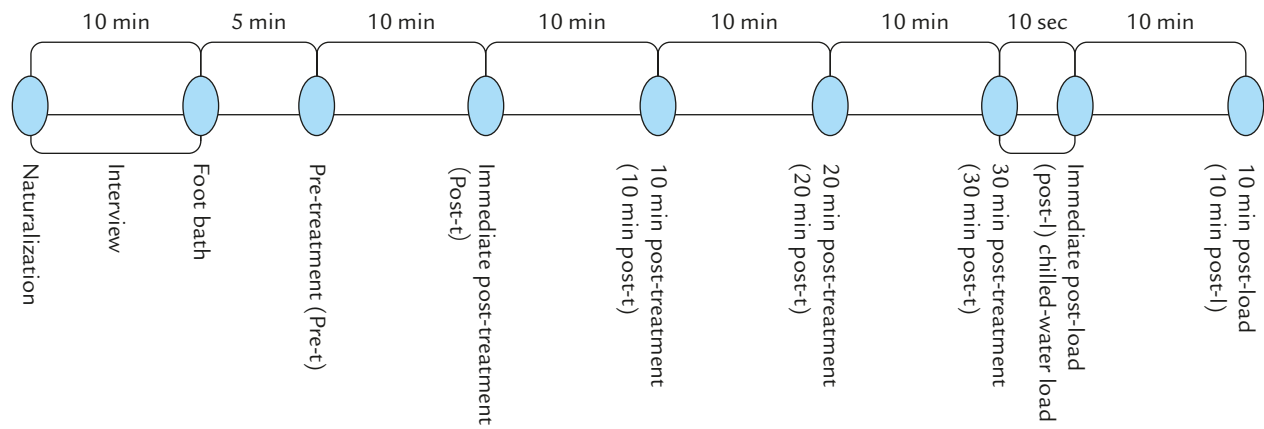


Figure 2 Experimental process for the measurement of skin temperature and blood flow over time.

kept at 4°C for 10 seconds as a chilled-water load after 30 minutes of being left in air post-treatment [2]. Before the reflexology treatment (Pre-t), measures of skin temperature and blood flow were taken at the baseline. Measurements were taken again immediately after treatment (Post-t), 10, 20, or 30 minutes thereafter (10min, 20min, 30min post-t), soon after the chilled-water load (post-l) and 10 minutes thereafter (10min post-l). The changes in blood flow and recovery rate were calculated based on skin temperature parameters using the following formulas [3]:

$$[\text{Change in blood flow} = \frac{(\text{blood flow at X minutes} - \text{blood flow pre-footbath})}{\text{blood flow pre-footbath}}]$$

$$[\text{Recovery rate (\%)} = \frac{(\text{temperature at X minutes after chilled-water load} - \text{temperature soon after chilled-water load})}{(\text{temperature before load} - \text{temperature soon after chilled-water load})} \times 100]$$

2.3. Statistical analysis

All quantitative data are presented as mean \pm standard deviation. Before-after statistical differences were evaluated by one-way analysis of variance using SPSS version 11.0 (SPSS Inc., Chicago, IL, USA). The levels of statistical significance were set to $p < 0.05$ and $p < 0.01$.

3. Results

3.1. General parameters

Table 2 shows the examinees' general parameters. The mean age of the subjects was 19.8 years of age, and the mean body weight, body fat percentage, moisture percentage, muscle percentage, and basal

Table 2 Characteristics of the participants in this study

Subject parameters (n=10)	Range	Mean
Age (yr)	18–22	19.8 \pm 2.4
Body weight (kg)	43.4–52	48.40 \pm 15.1
Body fat percentage (%)	18.5–20.5%	19.5% \pm 8.3
Moisture percentage (%)	52.3–57.7%	54.0% \pm 9.8
Muscle percentage (%)	34.4–37.2%	35.3% \pm 6.2
Basal metabolic rate (kcal/d)	1030–1200	1125.00 \pm 35.8

metabolic rate were 48.4kg, 19.5%, 54.0%, 35.3%, and 1125kcal, respectively. Eighty-three percent of subjects ate meals high in protein and low in carbohydrate. In the questionnaire on physical activity, 33% of subjects exercised for more than 15 minutes at least three times a week, while 67% had a sedentary lifestyle. Those who were troubled with lassitude in the lower half of their body or with swollen feet made up 43% and 57% of subjects, respectively.

In subjects with chilled fingers, an overwhelming 88% of the examinees complained of a chilled feeling in their toes and the soles of their feet in answer to the question “in which region do you have a chill?” Nearly 50% of the examinees with subjective cold intolerance were troubled with symptoms including headache, shoulder discomfort, lumbar fatigability and cold limbs. Likewise, half of the subjects also appeared to have swollen lower limbs. With regard to menstruation, approximately 80% of the subjects were found to suffer from a disturbed menstrual cycle or premenstrual lower abdominal pain (Table 3). In addition, since most of the subjects had a pale tongue covered with thin-white fur, and a deep and weak pulse. Cold intolerance is particularly relevant to Yang-deficiency according to TCM.

3.2. Instant skin temperature

Reflexology treatment was performed only on the left feet of participants. The skin temperatures at the KI-1, BL-60, and LR-3 measuring points on both sides at Post-t and 10 min post-t were significantly increased from those of the Pre-t (at the baseline), and the temperature elevation persisted in the treated foot at the LR-3 and BL-60 measuring points thereafter. However, no such persistence was seen on the untreated foot. Immediately after the chilled-water load had been applied, the skin temperatures at all measured points significantly decreased to the pre-treatment level. After waiting for 10 minutes, the reduced skin temperatures at the ambilateral points of LR-3 and KI-1, and at BL-60 on the left side recovered to the level observed at Pre-t, indicating a significantly faster recovery than at other measuring points. However, the temperatures of the ambilateral points of KI-3 and BL-60 on the right side did not recover until 10 min post-l (Table 4).

3.3. Changes in blood flow

Figure 3 shows the blood flow changes caused by reflexology. The blood flow in both feet was significantly increased at Post-t and 10 min post-t. As time advanced, the difference tended to disappear. At 20 min post-t, only the treated left foot showed a significant increase. Contrary to the significantly

reduced skin temperature at post-l, blood flow did not significantly decrease compared with that at Pre-t, and the same tendency continued for 10 minutes thereafter. These effects possibly contributed to the faster recovery in skin temperature.

Figure 4 shows the percentage changes in blood flow in both feet compared with Pre-t. Before treatment, the blood flow in both feet was almost equal (data not shown). However, after the reflexology therapy, the left and right feet showed 191% and 104%, 132% and 108%, 90% and 26%, and 60% and 34% increases at Post-t, 10 min post-t, 20 min post-t, and 30 min post-t, respectively. The blood flow of the treated foot tended to be higher than that of the untreated foot, but due to a considerable variation,

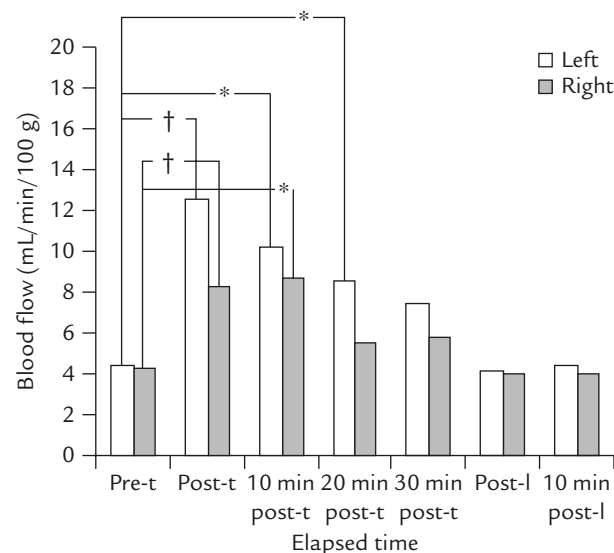


Figure 3 Blood flow changes induced by reflexology. *Significantly different from that at Pre-t ($p < 0.05$); †significantly different from that at Pre-t ($p < 0.01$). Pre-t=before the reflexology treatment; Post-t=after the reflexology treatment; Post-l=measurement taken after chilled-water load.

Table 3 Questionnaire results

Subject parameters ($n=10$)	Percentage (%)
Chilled foot (toe or sole)	88%±15
Subjective symptoms	52%±10
Menstrual disorder	78%±23

Table 4 Changes in instant skin temperature induced by reflexology treatment

Points	Pre-t	Post-t	10 min post-t	20 min post-t	30 min post-t	Post-l	10 min post-l
LR-3 (L)	27.6±1.2	30.4±0.8*	29.3±0.8*	28.7±1.1*	29.2±1.2*	21.5±1.4†	26.3±1.3
LR-3 (R)	27.4±1.2	29.5±0.5*	28.9±0.7*	28.8±1.0	28.4±1.2	22.0±1.4†	25.9±1.1
KI-3 (L)	28.7±1.1	29.6±1.1	29.7±0.6	29.8±0.8	29.8±1.1	23.1±1.3†	27.5±0.8*
KI-3 (R)	28.9±1.2	29.9±0.7	29.9±0.3	29.6±0.3	29.4±0.5	23.7±1.9†	27.0±1.1*
BL-60 (L)	27.2±1.3	29.5±0.4*	29.2±0.6*	29.2±0.9*	29.1±1.0	22.5±0.9†	26.6±1.1
BL-60 (R)	27.9±0.9	29.2±0.5*	29.0±0.7*	28.7±1.0	28.7±1.2	22.5±1.4†	26.0±1.1*
KI-1 (L)	26.4±1.4	30.3±0.4*	29.6±0.9*	29.5±1.0	28.6±1.3	23.1±1.3†	26.0±1.2
KI-1 (R)	26.5±1.6	29.7±0.6*	29.2±1.1*	28.7±1.1	28.0±1.2	23.1±1.3†	25.3±1.0

*Significantly different from that at Pre-t ($p < 0.05$); †significantly different from that at Pre-t ($p < 0.01$). L=left; R=right; LR-3=Taichong; KI-3=Taixi; BL-60=Kunlun; KI-1=Yongquan; Pre-t=before the reflexology treatment; Post-t=measurements taken immediately after treatment; 10 min post-t=measurement taken 10 minutes after treatment; 20 min post-t=measurement taken 20 minutes after treatment; 30 min post-t=measurement taken 30 minutes after treatment; Post-l=measurement taken after chilled-water load; 10 min post-l=measurement taken 10 minutes after chilled-water load.

no significant difference was seen between them. After application of the chilled-water load, the left foot showed a more rapid fall in blood flow than the right, which may have been due to the dilation of the blood vessels induced by treatment. After a lapse of 10 minutes, a tendency towards a faster recovery rate compared with the untreated foot was seen.

3.4. Recovery rate after chilled-water load

Figure 5 shows the recovery rate changes at the measured meridian points. Reflexology tended to contribute to an earlier recovery at all points of the treated foot compared with the untreated foot,

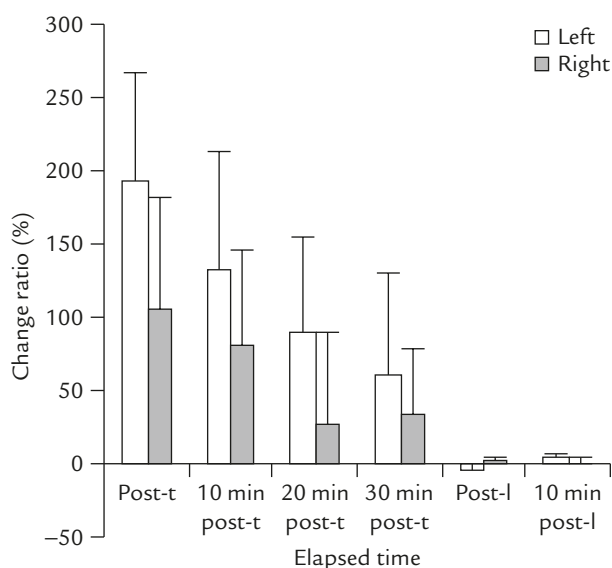


Figure 4 Analysis of the rate of change in blood flow. Post-t=after the reflexology treatment; Post-l=measurement taken after chilled-water load.

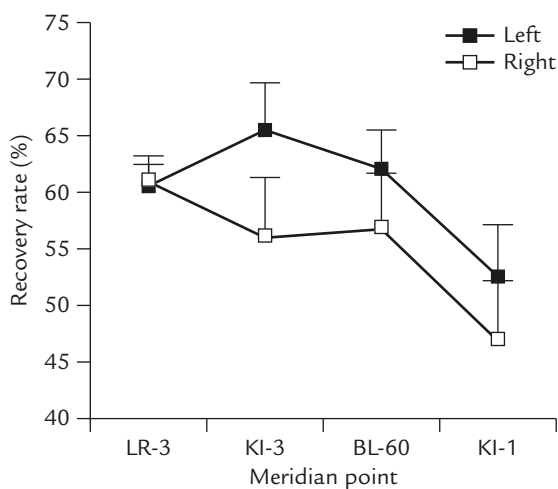


Figure 5 Recovery rate changes after the application of a chilled-water load (post-l).

however, no significant difference was found. The LR-3 points on both sides showed almost the same recovery rate. The KI-1 point showed the lowest recovery rate among all meridian points, which may have been due to the subjects' lower skin temperature at that point before foot bathing.

4. Discussion

Cold intolerance is an abnormal sensitivity to cold environments and cold temperatures. It is typically caused by diseases such as anemia, anorexia nervosa, chronic severe illness, hypothyroidism and vascular problems such as Raynaud's phenomenon. Except in the above related organic diseases, cold intolerance is considered as an indication of a metabolic problem. In our study, we chose 10 healthy students with subjective complaints of cold intolerance as examinees. According to their general parameters, they had a reduced moisture ratio compared with the mean of 60–65%, along with a lower muscle percentage of 35.3% compared with the mean of 40%. A lower body fat percentage than the normal level for females of 20–25% was also observed. The mean basal metabolic rate of the subjects was 1125kcal, which was slightly lower than the mean for 20 years of age (1209kcal/d) [4]. These results support the point of view that some people, often very slender women, do not tolerate cold environments simply because they have minimal body fat and are unable to keep warm [2].

Moreover, the fact that the subjects had a higher proportion of protein intake, 83%, compared with a basal meal model composed of 50% grain and 20% protein was elucidated by interview. Thirty-three percent engaged in more than 15 minutes exercise once or twice every week, meaning that those who exercised too little accounted for 67% of the subjects. These results suggested that unbalanced diets and a lack of exercise affect cold intolerance patients.

Reflexology involves stimulation of plantar reflection wards with a finger joint or the ball of a finger. It is said that there are more than 60 reflection wards on the foot, which are involved in the nervous, endocrine, cardiovascular, and lymphatic systems. Among these, the KI-1 point was the stimulation ward affected the most by finger joint pressure in our study. Since it is the Jing (well)-point on the Kidney Channel of Foot-Shaoyin, it is selected for the treatment of diseases along the course of the meridian, such as coldness and pain in the feet and knees, as well as pain in the lateral aspect of the femur [5]. Alternatively, the lowest skin temperature among the measuring sites before treatment indicated that the KI-1 point was the most chilled site, which also corresponded to the subjective symptoms of the

majority of the examinees. The skin temperature results showed a significant increase in both feet at the KI-1, LR-3, and BL-60 measuring points immediately after the therapy that lasted until 10 minutes after the reflexology treatment. After the application of the chilled-water load, a faster recovery to the baseline state in both feet at the KI-1 and LR-3 points was found at 10 min post-t, as well as at the BL-60 point on the left foot. However, the same change was not observed at the KI-3 measuring point. This may have been due to a softer pressure being applied to this region, together with its upper location meaning that the footbath water did not sufficiently immerse and warm this point before the experiment. These defects should be corrected in future studies.

Similarly, the blood flow results for the back of the third toe also matched the skin temperature data. The absence of a significant difference compared with the Pre-t at 20 min post-t in the skin temperature results may have been due to the longer foot exposure in air during the skin temperature measurement. Even though the treated foot showed a greater change in blood flow than the opposite foot, the absence of a significant difference between the treated and untreated feet suggested that reflexology on a foot has a local as well as systemic effect. The theory that the reflection wards of the foot are connected to all parts of the body via channels of energy also accords with the meridian theory and the therapeutic effects of acupoints seen in TCM.

Recovery rate changes based on those at each measuring point were calculated to estimate the restorative effect of a chilled-water load [2]. Although the KI-3, BL-60, and KI-1 points on the reflexology-treated foot showed higher recoveries than those on the opposite foot due to direct plantar stimulation, no significant difference was observed between the two feet. These findings also supported the general effects of reflexology therapy, and at the LR-3 point, exactly the same recovery rates were observed on both sides. This may have been due to its special location in comparison with the other measuring sites; i.e., LR-3 is immediately above an artery, and so the increase in blood circulation induced by reflexology treatment is spread to blood vessels and lymph channels more rapidly than in other regions. These trends in recovery rate corresponded to blood flow and skin temperature changes.

Reflexology is a natural treatment aimed at activating parts of the body by stimulating reflection wards in the foot. As a result of patient interviews, in addition to some menstrual disorders such as diminished and delayed menstruation in the female examinees, other symptoms such as chilled limbs, backache, and a sense of numbness or edema were also observed in our participants. According to TCM,

the spleen affects the limbs and plays a role in controlling the blood and keeping it circulating within the vessels. The kidney is considered to store the essence, which is related to menstruation and closely connected with water metabolism. On the other hand, cold intolerance is attributed to a Yang-deficiency of both the spleen and kidney in TCM [6]; therefore, the therapeutic principle of toning and warming the spleen and kidney seems to be appropriate. Indeed, during reflexology, some therapy zones including the LR-3, KI-3, BL-60, and Gongsun (SP-4) points, which belong to the liver, kidney, gall bladder, and spleen channels, respectively, were also touched and stimulated. From the feedback of the examinees, such as “I felt very relaxed by the direct stimulation”, “It improved my mental state”, “I felt rejuvenated”, and “I had a good sleep after the treatment”, it was suggested that the foot contains the ends of the nervous system and that can be attributed to the effects of reflexology in relieving stress, restoring physical balance, and promoting health in addition to increasing blood circulation. Further research concerning the role of sympathetic nerves in reflexology is needed.

In conclusion, the foot-reflexology treatment used in our study induced significant increases in skin temperature and blood flow compared with their pre-treatment levels in both feet. Due to the improvement of systemic blood circulation following treatment, we suggest that reflexology is an alternative therapy for cold intolerance.

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