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Perspective

Regularity of Human Body Temperature Change Induced by Various Aromatic Smokes

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ABSTRACT: Aromatherapy is a widely used clinical complementary therapy. Incense therapy, as one of the primary methods of aromatherapy, releases volatile aromatic compounds that rapidly interact with the human body. To explore its potential mechanisms, we collected 123 common natural aromatherapy fragrances and employed infrared thermography to record human surface temperature changes after smoke inhalation. The results showed that most incense samples could induce localized temperature increases, exhibiting eight stable and distinct heating patterns. These patterns show a phenomenological correspondence with the eight extra meridians described in traditional Chinese medicine. This phenomenon suggests that natural incense smoke may induce meridian-specific warming effects, which may provide thermographic evidence for the meridian hypothesis while also offering new perspectives for modern aromatherapy research.

Keywords: Aromatherapy; Incense; Human meridian; Infrared

1. Introduction

Incense therapy (aromatherapy) is a natural treatment that stimulates the human respiratory system and skin through the natural volatilization or combustion of plants of some animal secretions [1]. It serves as a complementary therapy to help restore the body and mind to a state of balance [2]. However, the systematic mechanism of aromatherapy has seldom been investigated. Traditional Chinese medicine (TCM) posits that aromatherapy may interact with the human meridian [3]. The meridian system is a core component of TCM theory, mainly including the six normal meridian pairs and eight extra meridians, and may be related to the diversity of the transmembrane channels. These views provide a new hypothesis that is worth experimentation and systematic validation.

Transmembrane transportation consumes ATP and generates thermal infrared signals. Infrared thermography, a non-invasive imaging technique, has been progressively introduced into meridian research in recent years [4]. Previously, we successfully used infrared imageries to capture the thermal effects of tea activating the human meridian system. We discovered that after drinking different types of tea, the temperature in both the fingers and organs increased significantly. These temperature changes highly corresponded with the six normal meridian pairs [5].

This study uses natural fragrances as a model to investigate the thermal effects of incense smoke on the human body surface through combustion experiments and infrared thermography, and to determine whether it exhibits consistent, classifiable thermal imaging characteristics.

2. Materials and Methods

The 123 kinds of incense samples selected for the experiment were ground and sieved. Six members of our research group (aged 20–50) served as healthy volunteers (M0–M5). All 123 aromatic smokes were tested in each participant (n = 6 per aromatic smoke). During the experiment, participants were prohibited from consuming any medications, tea, or seasonings to avoid potential interference. Prior to imaging, participants sat quietly in a temperature-controlled room (26–28 °C) for 20 min to stabilize body temperature. Each incense sample (500 mg) was burned in a controlled setting, and thermal images of both ventral and dorsal sides were captured at 10 min of combustion. The infrared camera (Ti450PRO Thermal Imager, Fluke Co., Everett, WA, USA) was fixed three meters from the subject, capturing the head, upper limbs, and torso. To minimize interference, only one fragrance was tested per day.

3. Results

The experiment showed that most natural fragrances induced a localized or systemic increase in temperature after 10 min of burning. Smoke of some fragrances, including *Aquilaria sinensis*, *Santalum album*, *Osmanthus fragrans*, *Prunus mume f. alba*, *Ruta graveolens*, *Thuja sutchuenensis*, *Rosa rugosa*, and *Syzygium aromaticum*, produced stable and significant surface warming patterns across multiple subjects (n = 6). These patterns were highly similar to the distribution pathways of the eight extra meridians (Figure 1).

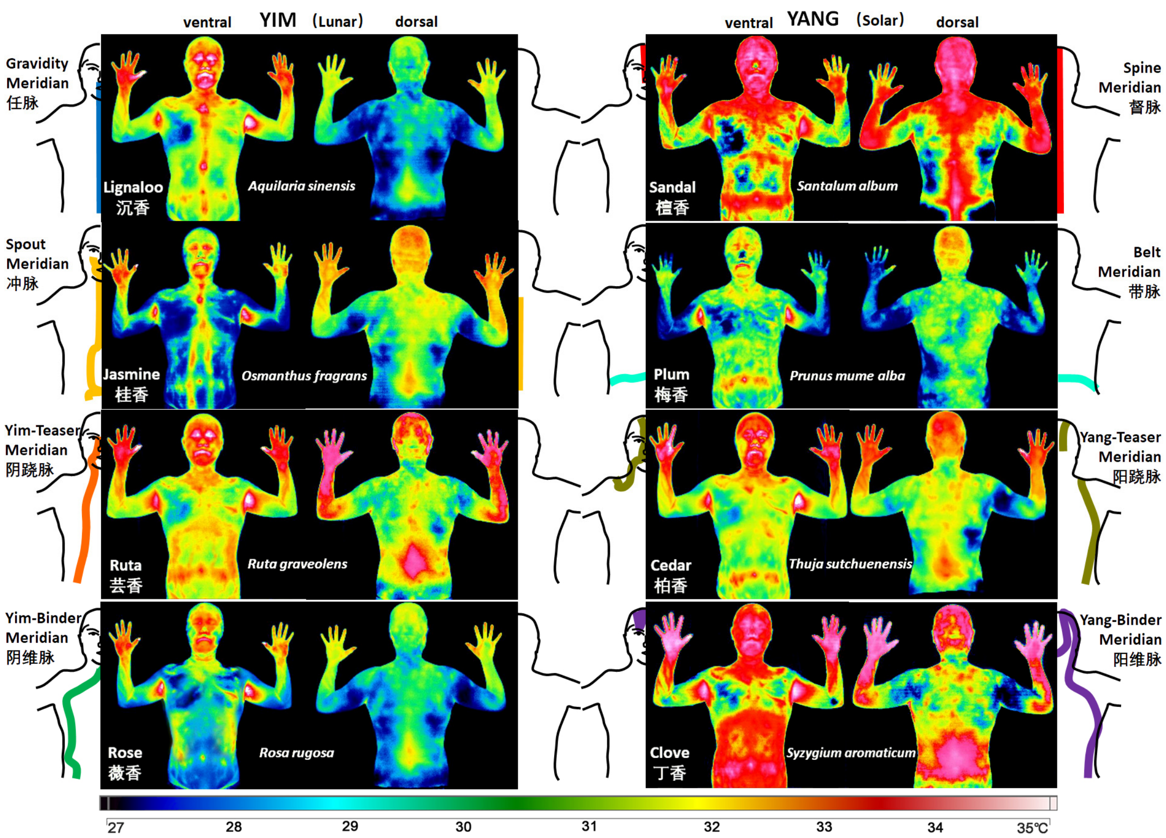

Figure 1. Infrared thermal imaging patterns induced by eight natural fragrances and the according eight extra meridian diagrams.

Images derived from participant M0, illustrating typical warming patterns. The eight representative fragrances shown in Figure 1 are listed in Table 1 using the same Latin names.

The warming induced by lignaloo mainly descends from the face along the midline of the abdomen, consistent with the Gravidity meridian. Sandalwood induces warming in the coccygeal vertebra, along the spinal midline to the head, consistent with the Spine meridian. The warming area of osmanthus (*Osmanthus fragrans*) is distributed around 3cm lateral to the midline of the abdomen and ascends along the inner side of the spine to the neck, which is consistent with the distribution of the Spout meridian. *Plum blossom* (*Prunus mume f. alba*) causes a circumferential warming pattern around the waist, corresponding to the Belt meridian. The warming areas of the common rue leaves are concentrated around 7 cm lateral to the midline of the abdomen, chest, and cheeks, matching the Yim-teaser meridian. *Thuja sutchuenensis* or cedar primarily warms the hips, shoulders, and eyes, aligning with the Yang-teaser meridian. Rose induces warming in the sides of the abdomen and the upper neck region, corresponding to the Yim-binder meridian. Clove triggers warming in the whole back and abdomen, shoulders, neck, and back side of the head, consistent with the Yang-binder meridian.

Beyond the representative samples above, warming effects of other fragrances can be categorized into one of these eight thermal effect patterns through image comparison or exhibit overlapping patterns (Table 1).

Table 1. Correspondence between the 123 natural fragrances and extraordinary meridians based on thermal imaging.

Chinese Name	Scientific Name	Family	Part Used	Eight Extra Meridians	Sample Origin
星洲沉香	*Aquilaria malaccensis* Lam	Thymelaeaceae	stem	Gravidity	Indonesia
海南沉香	*Aquilaria sinensis* (Lour.) Spreng	Thymelaeaceae	stem	Gravidity	Hainan, China
芽庄沉香	*Aquilaria crassna* Pierre ex Lecomte	Thymelaeaceae	stem	Gravidity	Vietnam
降真香	*Dalbergia odorifera* T.C.Chen	Fabaceae	stem	Gravidity	Guangxi, China
新山檀香	*Santalum album* L.	Santalaceae	stem	Spine	Indonesia
老山檀	*Santalum album* L.	Santalaceae	stem	Spine	India
东加砍片	*Melaleuca alternifolia* (Maiden & Betche) Cheel	Myrtaceae	stem	Spine	Indonesia
桂花	*Osmanthus fragrans* Lour.	Oleaceae	flower	Spout	Jiangsu, China
艾草	*Artemisia argyi* H.Lév. & Vaniot	Asteraceae	leaf	Spout	Hubei, China
薄荷	*Mentha haplocalyx* Briq.	Lamiaceae	leaf	Spout	Zhejiang, China
洛神花	*Hibiscus sabdariffa* L.	Malvaceae	flower	Spout	Jiangxi, China
香柏脂	*Cupressus funebris* Endl.	Cupressaceae	resin	Spout	Hunan, China
佩兰	*Eupatorium fortunei* Turcz.	Asteraceae	leaf	Spout	Fujian, China
泽兰	*Eupatorium japonicum* Thunb.	Asteraceae	leaf	Spout	Yunnan, China
茉莉	*Jasminum sambac* (L.) Aiton	Oleaceae	flower	Spout	Jiangsu, China
细辛	*Asarum sieboldii* Miq.	Aristolochiaceae	leaf	Spout	Japan
西非乳香	*Boswellia dalzielii* Hutch.	Burseraceae	resin	Spout	Benin
白梅	*Prunus mume f. alba* (Carrière) Rehder	Rosaceae	flower	Belt	Jiangsu, China
梅子肉	*Prunus mume* (Siebold) Siebold & Zucc.	Rosaceae	fruit	Belt	Jiangsu, China
红梅花	*Prunus mume* (Siebold) Siebold & Zucc.	Rosaceae	flower	Belt	Yunnan, China
芸香	*Ruta graveolens* L.	Rutaceae	leaf	Yim Teaser	Albania
芸香草	*Cymbopogon distans* (Nees ex Steud.) Will.Watson	Poaceae	leaf	Yim Teaser	Yunnan, China
陈皮	*Citrus × aurantium* L.	Rutaceae	fruit	Yim Teaser	Guangdong, China
迷迭香	*Salvia rosmarinus* Spenn.	Lamiaceae	leaf	Yim Teaser	Albania
百合花	*Lilium brownii* Lemoinier	Liliaceae	flower	Yim Teaser	Gansu, China
香茅草	*Cymbopogon citratus* (DC.) Stapf	Poaceae	leaf	Yim Teaser	Myanmar

排草	*Lysimachia foenum-graecum* Hance	Primulaceae	leaf	Yim Teaser	Guizhou, China
白兰花	*Magnolia* × *alba* (DC.) Figlar	Magnoliaceae	flower	Yim Teaser	Shanghai, China
九里香	*Murraya paniculata* (L.) Jack	Rutaceae	leaf	Yim Teaser	Yunnan, China
瓦苇	*Lemmaphyllum microphyllum* C.Presl	Polypodiaceae	leaf	Yim Teaser	Jilin, China
淡竹叶	*Lophatherum gracile* Brongn.	Poaceae	leaf	Yim Teaser	Anhui, China
香阿魏根	*Ferula assa-foetida* L.	Apiaceae	root	Yim Teaser	Iran
苦楝	*Melia azedarach* L.	Meliaceae	flower	Yim Teaser	Shanghai, China
香橼	*Citrus medica* L.	Rutaceae	fruit	Yim Teaser	Yunnan, China
岩兰	*Chrysopogon zizanioides* (L.) Roberty	Poaceae	leaf	Yim Teaser	Thailand
木姜子	*Litsea pungens* Hemsl.	Lauraceae	fruit	Yim Teaser	Fujian, China
橙子皮	*Citrus* × *sinensis* (L.) Osbeck	Rutaceae	fruit	Yim Teaser	Jiangxi, China
柠檬皮	*Citrus* × *limon* (L.) Osbeck	Rutaceae	fruit	Yim Teaser	Guangdong, China
小茴香	*Foeniculum vulgare* Mill.	Apiaceae	fruit	Yim Teaser	Hunan, China
茶叶	*Camellia sinensis* (L.) Kuntze	Theaceae	leaf	Yim Teaser	Fujian, China
麝香	*Moschus moschiferus* Linnaeus	Moschidae	secretion	Yim Teaser	Jilin, China
崖柏	*Thuja sutchuenensis* Franch.	Cupressaceae	stem	Yang Teaser	Shanxi, China
侧柏叶	*Platycladus orientalis* (L.) Franco	Cupressaceae	leaf	Yang Teaser	Anhui, China
云杉	*Picea asperata* Mast.	Pinaceae	leaf	Yang Teaser	Guizhou, China
肉豆蔻	*Myristica fragrans* Houtt.	Myristicaceae	fruit	Yang Teaser	Molukka, Indonesia
白胶香	*Liquidambar formosana* Hance	Altingiaceae	resin	Yang Teaser	Türkiye
麝香草粉	*Thymus zygis* L.	Lamiaceae	leaf	Yang Teaser	Algeria
黄葵	*Abelmoschus moschatus* Medik.	Malvaceae	root	Yang Teaser	Taiwan, China
荔枝壳香	*Litchi chinensis* Sonn.	Sapindaceae	fruit	Yang Teaser	Guangdong, China
白芍	*Paeonia lactiflora* Pall.	Paeoniaceae	flower	Yang Teaser	Anhui, China
枫香	*Liquidambar formosana* Hance	Altingiaceae	leaf	Yang Teaser	Hunan, China
槐叶萍	*Salvinia natans* (L.) All.	Salviniaceae	leaf	Yang Teaser	Shanghai, China
井口边草	*Pteris multifida* Poir.	Pteridaceae	leaf	Yang Teaser	Shanghai, China
龙涎香	*Ambergris* Linnaeus	Physeteridae	secretion	Yang Teaser	Japan
笃耨香	*Pistacia terebinthus* L.	Anacardiaceae	resin	Yang Teaser	Jordan
苏合香	*Liquidambar orientalis* Mill.	Altingiaceae	resin	Yang Teaser	Türkiye
香附子	*Cyperus rotundus* L.	Cyperaceae	root	Yang Teaser	Guangxi, China
红豆杉	*Taxus chinensis* (Pilg.) Rehder	Taxaceae	leaf	Yang Teaser	Zhejiang, China
甘松	*Nardostachys jatamansi* (D.Don) DC.	Caprifoliaceae	leaf	Yang Teaser	Qinghai, China
金银花	*Lonicera japonica* Thunb.	Caprifoliaceae	flower	Yang Teaser	Hubei, China
百里香	*Thymus mongolicus* (Ronniger) Ronniger	Lamiaceae	leaf	Yang Teaser	Mongolia
咖啡	*Coffea arabica* L.	Rubiaceae	fruit	Yang Teaser	Yunnan, China
桃胶	*Prunus persica* (L.) Batsch	Rosaceae	resin	Yang Teaser	Shanghai, China
雪松	*Cedrus deodara* (Roxb. ex D.Don) G.Don	Pinaceae	leaf	Yang Teaser	Tibet, China
玫瑰	*Rosa rugosa* Thunb.	Rosaceae	flower	Yim Binder	Syria
藿香	*Agastache rugosa* (Fisch. & C.A.Mey.) Kuntze	Lamiaceae	leaf	Yim Binder	Guangdong, China
郁金	*Curcuma aromatica* Salisb.	Zingiberaceae	root	Yim Binder	Fujian, China
澳檀	*Santalum spicatum* (R.Br.) A.DC.	Santalaceae	stem	Yim Binder	Australia

娑罗树脂	*Shorea robusta* C.F.Gaertn.	Dipterocarpaceae	resin	Yim Binder	Malaysia
荷花粉	*Nelumbo nucifera* Gaertn.	Nelumbonaceae	flower	Yim Binder	Jiangsu, China
白残花	*Rosa multiflora* var. cathayensis Rehder & E.H.Wilson	Rosaceae	flower	Yim Binder	Anhui, China
川芎	*Ligusticum chuanxiong* S.H.Qiu, Y.Q.Zeng, K.Y.Pan, Y.C.Tang & J.M.Xu	Apiaceae	root	Yim Binder	Sichuan, China
菊花	*Chrysanthemum* × *morifolium* (Ramat.) Hemsl.	Asteraceae	flower	Yim Binder	Zhejiang, China
石榴花	*Punica granatum* L.	Punicaceae	flower	Yim Binder	Xinjiang, China
七姊妹蔷薇	*Rosa multiflora var. carnea* Thory	Rosaceae	flower	Yim Binder	Zhejiang, China
烈香杜鹃	*Rhododendron anthopogonoides* Maxim.	Ericaceae	flower	Yim Binder	Sichuan, China
丁香	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	Myrtaceae	flower	Yang Binder	Java, Indonesia
尤加利	*Eucalyptus radiata* Sieber ex DC.	Myrtaceae	leaf	Yang Binder	Australia
花梨香	*Pterocarpus santalinus* L.f.	Fabaceae	stem	Yang Binder	Hainan, China
麻黄根	*Ephedra sinica* Stapf	Ephedraceae	root	Yang Binder	Fujian, China
买麻藤	*Gnetum montanum* Markgr.	Gnetaceae	stem	Yang Binder	Guangxi, China
肉桂	*Cinnamomum verum* J.Presl	Lauraceae	stem	Yang Binder	Zhejiang, China
红千层	*Callistemon rigidus* R.Br.	Myrtaceae	leaf	Yang Binder	Australia
夜来香	*Cestrum nocturnum* L.	Solanaceae	flower	Yang Binder	Yunnan, China
缅栀	*Plumeria rubra* L.	Apocynaceae	flower	Yang Binder	Singapore
蓝桉	*Eucalyptus globulus* Labill.	Myrtaceae	leaf	Yang Binder	Yunnan, China
天竺桂	*Cinnamomum japonicum* Siebold	Rubiaceae	leaf	Yang Binder	Zhejiang, China
木香	*Aucklandia costus* Falc.	Asteraceae	flower	Yang Binder	Jiangsu, China
木贼	*Equisetum hyemale* L.	Equisetaceae	stem	Yang Binder	Shanghai, China
柳树花	*Salix babylonica* L.	Salicaceae	flower	Yang Binder	Shanghai, China
牡丹	*Paeonia* × *suffruticosa* Andrews	Paeoniaceae	flower	Yang Binder	Henan, China
灰藓	*Hypnum plumaeforme* Wilson	Hypnaceae	leaf	Yang Binder	Shanghai, China
桔梗	*Platycodon grandiflorus* (Jacq.) A.DC.	Campanulaceae	root	Yang Binder	Liaoning, China
腊梅花	*Chimonanthus praecox* (L.) Link	Calycanthaceae	flower	Yang Binder	Shanghai, China
银杏叶	*Ginkgo biloba* L.	Ginkgoaceae	leaf	Yang Binder	Shanghai, China
基枝藻	*Basicladia chelonum* (Collins) W.E.Hoffmann & Tilden	Cladophoraceae	leaf	Yang Binder	Shanghai, China
薰衣草	*Lavandula angustifolia* Mill.	Lamiaceae	flower	Yang Binder	Spain
醉鱼草	*Buddleja lindleyana* Fortune	Buddlejaceae	flower	Yang Binder	Shanghai, China
桂皮	*Cinnamomum cassia* (L.) J.Presl	Lauraceae	stem	Yang Binder	Zhejiang, China
金丝桃	*Hypericum monogynum* L.	Hypericaceae	flower	Yang Binder	Shanghai, China
苏铁子	*Cycas revoluta* Thunb.	Cycadaceae	fruit	Yang Binder	Shanghai, China
黄芪	*Astragalus membranaceus* (Fisch.) Bunge	Fabaceae	root	Yang Binder	Shanxi, China
多香果	*Pimenta dioica* (L.) Merr.	Myrtaceae	fruit	Yang Binder	Jamaica

草果	*Amomum tsao-ko* Crevost & Lemarié	Zingiberaceae	fruit	Yang Binder	Yunnan, China
甲香	*Turbo chinensis* Ozawa & Tomida	Turbinidae	operculum	Yang Binder	Guangdong, China
桃花	*Prunus persica* (L.) Batsch	Rosaceae	flower	Spine + Belt	Shanghai, China
紫苏	*Perilla frutescens* (L.) Britton	Lamiaceae	leaf	Spout + Yim Teaser	Shanghai, China
依兰	*Cananga odorata* (Lam.) Hook.f. & Thomson	Annonaceae	flower	Spout + Yim Teaser	Myanmar
卡式乳香	*Boswellia sacra* Flück.	Burseraceae	resin	Gravidity+ Yang Teaser	Somalia
泽兰	*Lycopus lucidus* Turcz. var. *hirtus* Regel	Lamiaceae	leaf	Spout + Yang Teaser	Yunnan, China
鼠尾草	*Salvia officinalis* L.	Lamiaceae	flower	Spout + Yang Teaser	Nepal
阿曼乳香	*Boswellia sacra* Flück.	Burseraceae	resin	Spout + Yang Teaser	Oman
辛夷花	*Magnolia liliiflora* Desr.	Magnoliaceae	flower	Spout + Yang Binder	Hubei, China
樟木	*Cinnamomum camphora* (L.) J.Presl	Lauraceae	stem	Spout + Yang Binder	Shanghai, China
山柰	*Kaempferia galanga* L.	Zingiberaceae	stem	Belt + Yim Teaser	Guangdong, China
马鞭草	*Verbena officinalis* L.	Verbenaceae	flower	Yim Teaser + Yang Teaser	Zhejiang, China
马缨丹	*Lantana camara* L.	Verbenaceae	flower	Yim Teaser + Yang Teaser	Jiangxi, China
石楠	*Photinia serratifolia* (Desf.) Kalkman	Rosaceae	flower	Yim Teaser + Yang Teaser	Shanghai, China
安息香	*Styrax tonkinensis* (Pierre) Craib ex Hartwich	Styracaceae	resin	Yim Teaser + Yang Teaser	Iran
紫荆	*Cercis chinensis* Bunge	Fabaceae	flower	Yim Teaser + Yang Binder	Shanghai, China
香石竹	*Dianthus caryophyllus* L.	Caryophyllaceae	flower	Yim Teaser + Yang Binder	Shanghai, China
白花鬼针	*Bidens alba* (L.) DC.	Asteraceae	leaf	Yang Teaser + Yim Binder	Yunnan, China
草木樨	*Melilotus officinalis* (L.) Lam.	Fabaceae	leaf	Yim Binder + Yang Binder	Shanghai, China

Note: The background colors are corresponding to those of the meridian diagrams in Figure 1.

4. Discussions and Conclusions

This study was the first time to systematically observe and categorize thermal response patterns induced by natural incense smoke in the human body. Results showed that most incense types could be grouped into eight thermal patterns, which highly correspond with the eight extra meridians in TCM. This suggests that natural aromatherapy fragrances may induce localized temperature increases by acting on specific pathways, providing imaging-level observations that resemble classical meridian descriptions. Furthermore, molecules absorbed through the respiratory system trigger entirely different meridian effects from those absorbed through the digestive system, *i.e.*, those through the respiratory system enter the eight extra meridians, while those through the digestive system enter the six normal meridian pairs. These observations further suggest that the traditional classification of TCM meridians may reflect underlying, yet currently undefined, principles of physiological organization, which warrant further systematic investigation.

Although the present study focuses only on the phenomenology of thermal patterns, the observed spatial heterogeneity in surface temperature responses may be contributed to by several biological factors. Regional differences in the types and density of sensory receptors [6,7], autonomic nerve innervation [8,9], microvascular distribution [10–12], and tissue metabolic activity could all influence how inhaled aromatic compounds modulate local heat dissipation. These factors may shape reproducible thermal configurations without implying discrete anatomical conduits. At present, such considerations remain speculative and serve primarily to outline biologically plausible contexts for future mechanistic investigations.

Infrared thermography is inherently sensitive to environmental and physiological fluctuations. In this study, reproducibility was evaluated not through absolute temperature values but through the recurrence of spatial thermal configurations across individuals exposed to identical fragrance types. While generalized autonomic responses, such as vasodilation induced by smoke inhalation, may contribute to global warming effects, they are unlikely to fully explain the consistent, pathway-like distributions repeatedly observed. This suggests that the thermal patterns reflect structured physiological responses rather than random or purely systemic effects.

Several limitations must be acknowledged. First, the number of participants was limited, limiting population-level generalization and precluding statistical modeling of inter-individual variability. The present classification emphasizes pattern recurrence rather than quantitative magnitude or prevalence. Second, correspondence between thermal patterns and the eight extra meridians should be interpreted as a conceptual analogy derived from TCM theory, rather than as evidence of discrete physiological structures. Terms such as “meridian-specific warming effects” are used descriptively to facilitate interdisciplinary dialogue, not to assert mechanistic equivalence.

In aromatherapy, the chemical composition and relative abundance of smoke constituents released during the combustion of natural incense are key factors influencing their physiological effects. Future studies should employ gas chromatography–mass spectrometry (GC–MS) to systematically characterize the chemical profiles of smoke derived from different natural incense materials. Comparative analysis of differential components may help elucidate common patterns underlying their physiological effects and potential molecular mechanisms. In parallel, expanding participant cohorts will facilitate quantitative assessment of inter-individual variability, response stability, and statistical robustness. Together, these approaches may help bridge phenomenological observations with molecular and physiological mechanisms.

Author Contributions

Conceptualization, H.L.; Methodology, H.L. and W.J.; Software, W.J.; Validation, H.L., W.J. and L.Y.; Formal Analysis, M.W. and L.Y.; Investigation, L.Y. and X.B.; Resources, H.L. and L.Y.; Data Curation, M.W.; Writing—Original Draft Preparation, M.W.; Writing—Review & Editing, H.L.; Visualization, W.J.; Supervision, H.L.; Project Administration, H.L.; Funding Acquisition, H.L.

Ethics Statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of Fudan University School of Life Sciences (BE1945, 18 December 2019).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

There are no additional data for this paper other than published in the manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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