ORIGINAL ARTICLE

Thermal Conductivity of the Body in Students from Kyrgyzstan, India and China

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Abstract

Background: According to physicists, thermal conductivity (*k*) refers to the rate at which thermal energy and the interaction of microparticles transfer energy from warmer to colder parts of the body. To maintain body temperature homeostasis under changing conditions in the external or internal environment, macroscopic organisms should differ in their *k* of the body. The objective of the study is to evaluate the *k* of the body in students from Kyrgyzstan, India, and China. **Materials and Methods:** In this study, 600 students from various racial and ethnic groups attended institutions in Bishkek, Kyrgyzstan, including 200 students from each of the following groups: Kyrgyz, Indian, and Chinese. The Kyrgyz and Indian (Uttar Pradesh and Punjab, India) students from the Kyrgyz State Medical Academy, the International Higher School of Medicine, and the Chinese (Guangzhou Province, China) students from the Kyrgyz Pedagogical University in Bishkek, Kyrgyzstan, were studied to determine if race or ethnicity could affect the *k* of the body. **Results:** There were significant differences between the values of *k* among the students of India and China, Kyrgyzstan and China, while the alleged relationship between Indians and Kyrgyz did not appear which indicates a possible similarity between the *k* of the bodies of two nationalities. **Conclusion:** Variation was observed in the *k* of various national groups in comparison to one another. The Kyrgyz and Indian students have a similar distribution of *k* values, but the Chinese students have a distinct pattern.

Key words: Average temperatures, ethnic groups, internal body temperature, thermal conductivity

INTRODUCTION

According to physicists, thermal conductivity (*k*) refers to the rate at which thermal energy and the interaction of microparticles transfer energy from warmer to colder parts of the body. With *k*, internal body temperatures stabilize. One of the three transfer phenomena observed in nature, along with thermal conductivity, diffusion, internal friction, and viscosity, is known as *k* due to energy transfer. All substances, including gases, liquids, and solids, have a *k* of the body. Due to the absence of convection in solids, unlike in gases and liquids, heat can only transfer through thermal conduction.[1-5]

Basically, the idea that the human body has some *k* is not a new one. Well-known human body density heterogeneity may explain this. Furthermore, because most tissues have low heat conductivity, direct heat conduction plays a minor role in the distribution of heat in the human body. In contrast, the key components of organ-based physiological thermoregulation have undergone significant studies, and current studies focus on examining their intricate connections at the cellular and molecular levels.[2-13]

To maintain body temperature homeostasis under changing conditions in the external or internal environment, macroscopic organisms should differ in their *k* of the body.[3,13] There are facts and observations that implicitly suggest genetic variability in the *k* of the body in humans:

1. Humans have the most advanced thermoregulation compared to primates and carnivores.
2. Individuals in a population react differently to extreme heat and cold.

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3. In addition to all of their other well-known characteristics, only humans have been able to colonize the entire surface of the Earth, including such severe habitats as the Far North and high mountain ranges, while continuing to be a single tropical biological species.[5] In addition, all of this occurred in a brief period of time (between 30,000 and 50,000 years), which is unparalleled in the history of life.[1]

Assuming that there is some association between the *k* of the body and its capacity to maintain a generally constant temperature in the body (temperature homeostasis), we aimed to conduct a study to determine the possible role of the *k* of the body in terms of nationality. The objective of the study is to evaluate the *k* of the body in students from Kyrgyzstan, India, and China.

MATERIALS AND METHODS

In this study, 600 students from various racial and ethnic groups attended institutions in Bishkek, Kyrgyzstan, including 200 students from each of the following groups: Kyrgyz, Indian, and Chinese.

The Kyrgyz and Indian (Uttar Pradesh and Punjab, India) students from the Kyrgyz State Medical Academy, the International Higher School of Medicine, and the Chinese (Guangzhou Province, China) students from the Kyrgyz Pedagogical University in Bishkek, Kyrgyzstan, were studied to determine if race or ethnicity could affect the *k* of the body.

At the beginning of our study, an approach developed in 2007 was used to evaluate *k* of the bodies of individuals. The *k* of the body was measured indoors at room temperature (20°C–24°C). A mercury thermometer was initially used to take measurements from the individual's left armpit and palm. A temperature gradient was established between the body of the individual under study and a source of thermal energy using this measurement to make "hot" water (thermos with "hot water.") Through trial and error, we were able to determine that 9°C is the optimum temperature differential between the palm's temperature and the "hot" water. Thus, the number nine was added to the thermometer reading to provide "hot" water for an individual in particular. In this regard, 40°C should be the temperature of "hot" water for people whose palm is 31.0°C.[4]

The "hand volume" of the participants in the study was then measured. This was carried out by gradually immersing the examined individual's left hand, up to the wrist, in a vessel filled with water. Another vessel without any water underneath this one held the water that the subject of the study had displaced with his or her hand and measured in cm^3. To provide the required volume of water for direct *k* of the body, the value of this number was then multiplied by four. Such a volume of "hot" water is generated so that the individual's hand is free in the water without contacting the thermos walls and to reduce the hand volume's influence on body measurement accuracy.

Statistical analysis was performed using Statistica v8.0 (StatSoft Inc., Tulsa, USA). The obtained data are presented as the mean±standard deviation. Differences in parameters were assessed using the Student's t-test. Differences were considered statistically significant at $P < 0.05$. Confidentiality was maintained concerning the data collected, and this study was approved by the International Higher School of Medicine Bioethics Committee (Protocol No. 125 dated May 12, 2022).

RESULTS

In thermophysics, the calorimetric method is used to calculate the thermal conductivity coefficient to estimate the *k* of solids (i.e., metals). A metal rod used in a calorimeter with water at T1 and T2 temperatures (T1>T2) allows for the transfer of heat through it. It is important to conduct an experiment to calculate the heat transfer rate and the time to estimate the *k* of a specific metal rod.

For both technical and ethical reasons, the direct transfer of the *k* measurement method used in thermal physics to the human body is unacceptable. However, by evaluating the *k* of only some parts of the human body, we aimed to approach the answer to this issue indirectly. To do this, we had to adapt physicists' commonly recognized methods to make them understandable to others.

Inanimate and living solids have distinct systems for balancing their internal temperatures. In the first instance, the mechanism relies on *k*, while in the second; the mechanism also involves fluids that circulate within the body (blood, lymph, and tissue juices). Since blood temperature is strictly regulated by the hypothalamus, the major system of physiological thermoregulation, there is no question that the large range of *k* that we found in a population cannot be related to blood temperature. As a result, it appeared quite likely that another factor may be the cause of the population's differences in terms of each person's body's *k*. However, evaluating the body's *k* objectively was a challenge. We were compelled to adjust the procedure for the human body while keeping its fundamental idea (the formation of a temperature gradient) because a straight application of the approach often used in thermal physics proved to be impossible. Table 1 shows the distribution of *k* of the body among individuals of various nationalities.

Based on the data in Table 2, we obtained a significant difference between the values of *k* among the representatives of India and China, Kyrgyzstan and China, while the alleged relationship between Indians and Kyrgyz did not appear which indicates a possible similarity between the *k* of the bodies of two nationalities. The Chinese, as representatives of an ancient ethnic group, are distinguished by their *k*, probably due to anthropometric features.

Table 1: Distribution of *k* of the body in persons of different national groups (1.2: low level of thermal conductivity; 5.2: high level of thermal conductivity)

Value of *k*	Indian students (*n*=200) I	Chinese students (*n*=200) II	Kyrgyz students (*n*=200) III
1.2	2	2	13
1.6	13	1	1
1.8	6	2	2
2.0	6	1	18
2.2	6	2	2
2.4	6	6	6
2.6	6	2	6
2.8	6	4	13
3.0	26	5	36
3.2	20	31	19
3.4	6	11	5
3.6	13	13	7
3.8	20	15	19
4.0	13	32	20
4.2	26	23	1
4.4	6	13	6
4.6	2	13	3
4.8	2	13	20
5.0	13	6	2
5.2	2	5	1
M±m	3.32±0.17	3.82±0.12	3.19±0.17
Student's t-test	$T_{1/2}$=2.391	$T_{2/3}$=3.03	$T_{1/3}$=0.54
P	0.02	0.004	0.59

All data are expressed as M±m. **P*<0.05.*k*=thermal conductivity. M±m=mean±standard deviation

Table 2: Distribution of palm temperature in persons of different national groups

PalmT^{0}C	Indian students (*n*=200) I	Chinese students (*n*=200) II	Kyrgyz students (*n*=200) III
22	2	2	6
23	3	1	2
24	1	2	1
25	3	2	20
26	2	2	4
27	1	3	6
28	2	1	7
29	4	1	2
30	6	1	42
31	13	2	1
32	20	5	6
33	17	44	38
34	73	104	44
35	46	28	19
36	7	2	2
M±m	33.8±0.25	33.9±0.13	31.2±0.63
T-Student	$T_{1/2}$=0.35	$T_{2/3}$=3.84	$T_{1/3}$=4.2
P	0.72	0.001	0.001

All data are expressed as M±m. **P*<0.05. M±m=mean±standard deviation

DISCUSSION

The temperature regime of the peripheral part of the body (palm) reflects the average value in the population, so we found that the temperature of the palm of Indians and Chinese is about 2°C higher relative to Kyrgyzstan. The *k* of the students from China differed from that of Kyrgyzstan and India; the equality of the average palm temperatures between the Indian and Chinese students questions the existing hypothesis of cellular thermoregulation and *k*.[4]

This study aimed to test the hypothesis of cellular thermoregulation.[4] The possibility of the existence of a wide hereditary variability in human *k* of the body in a population arose due to this hypothesis.[14-21]

The following findings substantiated the hypothesis of cellular thermoregulation: (1) All eukaryotes, including fungi and mammals, have an excess of repetitive sequences in the nucleus known as "junk DNA;" (2) a large portion of this junk DNA does not encode any simple phenotypic function; (3) excess DNA is complexed with proteins into highly compacted structures known as condensed chromatin; and (4) in the interphase cell, junk DNA, including homologous chromosomes, is located in the periphery of the cell.

Basically, depending on climatic zones, thermoregulation and *k* of the body should have been related. In a hypothetical situation, the Chinese and Kyrgyz would have more data in common and would have different *k* of the body and palm temperatures in the cohort with the Indians. A finding from our study that directly contradicts the hypothesis and therefore disproves it was stated.

CONCLUSIONS

Variation was observed in the *k* of various national groups in comparison to one another. The Kyrgyz and Indian students have a similar distribution of *k* values, but the Chinese students have a distinct pattern. The average temperatures of the participants' palms showed that the Kyrgyz ethnic group and the Chinese and Indian ethnic groups differed substantially from one another in terms of parameters.

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AUTHOR CONTRIBUTIONS

Conception, design of the work, manuscript preparation, and data acquisition: StalbekAkhunbaev, OrozalyUzakov, Tugolbai Tagaev, and Yethindra Vityala. Clinical management: StalbekAkhunbaev and OrozalyUzakov.

REFERENCES

1. Romanovsky AA. Thermoregulation: Some concepts have changed. Functional architecture of the thermoregulatory system. Am J Physiol Regul Integr Comp Physiol 2007;292:R37-46.
2. Ivanov KP. Modern medical problems of energy exchange in humans. Vestn Ross Akad Med Nauk 2013;6:56-9.
3. Vendrik AJ, Vos JJ. A method for the measurement of the thermal conductivity of human skin. J Appl Physiol 1957;11:211-5.
4. Ibraimov AI. Condensed chromatin and cell thermoregulation. Complexus 2003;1:164-70.
5. Ivanov KP. New biological problems in the energetics of living systems. Adv Mod Biol 2016;136:586-92.
6. Luchakov YI, Arokina NK, Nesmeyanov AA. Convective and conductive heat transfer in various bodies. Bull New Technol 2018;12:40-50.
7. Luchakov YI, Kamyshev NG, Shabanov PD. Heat transfer by blood: Adjustable calculated and experimental data. Rev Clin Pharmacol Drug Ther 2009;7:3-20.
8. Luchakov YI. Heat transfer in the tissues of a homoiothermic organism. Clin Med Pharmacol 2017;3:39-45.
9. Luchakov YI, Shabanov PD. Heat transfer to the skin. Rev Clin Pharmacol Drug Ther 2017;15:68-71.
10. Luchakov YI, Shabanov PD, Nesmeyanov AA. Features of thermoregulation in living systems (literature review). Clin Med Pharmacol 2016;2:13-20.
11. Rojas-Altamirano G, Vargas RO, Escandón JP, Mil-Martínez R, Rojas-Montero A. Calculation of effective thermal conductivity for human skin using the fractal Monte Carlo method. Micromachines (Basel) 2022;13:424.
12. Slavinec M, Repnik R, Klemenčič E. The impact of moisture on thermal conductivity of fabrics. Anali Pazu 2016;6:8-12.
13. Luchakov II, Shabanov PD. Thermal homeostasis of the rabbit in thermoneutral zone (mathematic modeling). Ross Fiziol Zh Im I M Sechenova 2013;99:1089-96.
14. Ibraimov AI, Tabaldiev SK. Condensed chromatin, cell thermoregulation and human body heat conductivity. J Hum Ecol 2007;21:1-22.
15. Ibraimov AI. The origin of condensed chromatin, cell thermoregulation and multicellularity. Complexus 2004;2:23-34.
16. Ibraimov AI, Karagulova GO. Chromosomal Q-heterochromatin regions in individuals of various age groups. Int J Hum Genet 2006;6:219-28.
17. Ibraimov AI, Karagulova GO. Chromosomal Q-heterochromatin variability in neonates deceased during first year of age. Int J Hum Genet 2006;6:281-5.
18. Ibraimov AI. On the pathogenesis of atherosclerosis: The role of the blood temperature, phase transitions of lipoproteins and turbulence of blood flow. J Hum Ecol 2008;23:195-201.
19. Ibraimov AI, Kazakova AK, Moldotashev IK, Sultanmuratov MT, Abdyev KS. Variability of human body heat conductivity in population. I. Methodological and theoretical approaches. J Hum Ecol 2010;32:1-22.
20. Ibraimov AI, Kazakova AK, Moldotashev IK, Sultanmuratov MT, Abdyev KS. Variability of human body heat conductivity in population. II. Diseases of civilization. J Hum Ecol 2010;32:69-78.
21. Ibraimov AI. Human adaptation: Why only genes? Int J Biol Med 2019;1:22-33.

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