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Research Article

COVID-19: Another Important Factor Aggravating the Course of the Disease

Abyt Ibraimov [1,2*], Stalbek Akhunbaev[1], Orozali Uzakov[1], Argen Alymkulov[1], Mayramkan Kerimaly [1] and Tahmina Tayirova[1].
[1]International Higher School of Medicine, Bishkek, Kyrgyzstan.
[2]National Center of Cardiology and Internal Medicine, Bishkek, Kyrgyzstan.

International Higher School of Medicine, Bishkek, National Center of Cardiology and Internal Medicine, Bishkek, Kyrgyzstan.

***Corresponding Author:** Abyt Ibraimov, International Higher School of Medicine, Bishkek, National Center of Cardiology and Internal Medicine, Bishkek, Kyrgyzstan.

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Abstract

Apparently, COVID-19 can infect all individuals in the human population. However, not everyone is seeking medical help. Perhaps most people carry the infection relatively easily, and some may not notice at all that they have contracted COVID-19. Nevertheless, some infected individuals still seek medical help, and some of them need inpatient treatment (hospitalization). Factors aggravating the course of COVID-19 are known. Among these factors, the most important was the age of a person and obesity. There are other factors that can affect the course of the disease: low blood oxygen saturation (below 88%), diabetes, chronic heart disease, weak immunity, vitamin D and K deficiency. Our own experience has shown that there may be another important factor that could affect the severity of the clinical course of COVID-19. By this factor we mean a little-studied physical characteristic of a human, namely the level of thermal conductivity of his body. In particular, it turned out that individuals with low thermal conductivity of the body are more difficult to tolerate COVID-19.

Key words: COVID-19; human body heat conductivity; human age; obesity; heterochromatin; temperature homeostasis

Introduction

Apparently, with COVID-19, all individuals in the population can become infected. However, not all infected individuals go to the hospital or seek medical help. Factors aggravating the course of COVID-19 are known. Among these factors, the most important was the age of a person. In particular, the older the patient, the higher the probability of a difficult course of the disease. Statistics showed that the most common indications for hospitalization were in patients over 75 years old, as well as people over the age of 65 and those who were obese. The factor that most strongly influenced the severe course of the disease was the low oxygen saturation of the blood (below 88%). There are other factors that can affect the course of the disease: diabetes, chronic heart disease, weak immunity, vitamin D and K deficiency [1].

These circumstances prompted us to pay attention to the possible role of another factor that could affect to the vulnerability, and the severity of the clinical course of COVID-19. By this factor, we mean some the physical characteristics of the human bodies, namely the level of their thermal conductivity. Since this constitutional feature of the human body has a hereditary nature and is still little known to clinicians, it was considered necessary to give very short information.

It turned out that the exact measurement of the thermal conductivity of the body of living organisms, including humans, is a completely unexplored problem. In the literature available to us, we could not find not only a special method, but also even any attempt to estimate the thermal conductivity of macroscopic organisms [2-5].

As is known, thermal conductivity is the transfer of energy from more heated parts of the body to less heated bodies because of thermal motion and interaction of micro particles. Thermal conductivity leads to equalization of body temperature. Thermal conductivity due to energy transfer is one of the three transfer phenomena existing in nature (thermal conductivity, diffusion and viscosity). All substances possess thermal conductivity: gases, liquids and solids. In solids, unlike gases and liquids, convection is impossible, so heat transfer is carried thermal conductivity. In thermophysics, the thermal conductivity of solids (e.g. metal) is measured by determining the thermal conductivity coefficient by the calorimetric method. Heat transfer occurs through a metal rod, the ends of which are placed in a calorimeter with water taken at temperatures T_1

и T_2 ($T_1 > T_2$). To measure the thermal conductivity coefficient of a given metal rod, it is necessary to determine the amount of heat transferred and time by experience.

It is obvious that the direct transfer of the method of measuring thermal conductivity used in thermophysics is not acceptable for the human body, both for technical and ethical reasons. However, we tried to approach the solution of this problem indirectly by estimating the thermal conductivity of only a part of the human body (hereinafter, the human body heat conductivity [BHC]). To do this, we had to modify the generally accepted method of physicists so that it was acceptable to humans. By trial and error, we have developed two methods for assessing a human BHC. The first method is adapted for stationary (e.g. in laboratory conditions), and the second for "field" research ("express method"). The stationary method requires special equipment and temperature conditions for conducting calorimetric studies. The second method is very simple, takes little time and does not require expensive devices and specially trained personnel. To implement this technique, it is enough to have a pyrometer (a device that has become popular since the COVID-19 pandemic for non-contact measurement of forehead temperature in people on the street, in public transport, airports, etc.) and nursing staff, which measures the surface temperatures of the forehead and palm (for details see [2-5]). In this study, we used only the express method to assess human BHC.

Materials and Methods

The objects of the study were female individuals of Kyrgyz nationality at reproductive age. Female students of educational institutions in Bishkek were studied as a control group. The study sample included individuals who received medical care in hospitals specially organized for the treatment of patients with COVID-19 and were discharged as recovered patients (reconvalescents). The choice of female reconvalescents was due to a number of reasons: a) in females in the population, the level of BHC is, on average, lower than in men; b) there is no Y chromosome in the karyotype of women, which carries the largest block of constitutive heterochromatin in the human genome, responsible for the high level of BHC; c) constitutive heterochromatin on the Y chromosome is also characterized by high variability (polymorphism) in the population [2,3,5].

To assess the human BHC, the surface temperatures of the forehead and right palm of the examined individuals were measured. For the convenience of analyzing the numerical results of experiments with all measurements, when the pyrometer readings coincided with an odd number, its values were underestimated by one tenth of a degree to get an even number. For example, if the pyrometer showed at 31.5 ° C, it was recorded as 31.4 °C. After measuring the temperature of the forehead and palm, the differences between these two characteristics were calculated to assess the level of BHC of this individual [3,5,6].

Previously, we established the existence of a connection between the temperature difference between two parts of the body (for example, the surface of the palm and forehead) and the human BHC [2-5]. In particular, it was shown that the smaller the temperature difference between the palm and the forehead surface, the higher the human BHC, and *vice versa*. If the temperature difference between the palm and the forehead does not exceed 1.0 ° C, then such an individual has a high BHC. If this difference exceeds 2.1 °C, then such an individual has a body with low heat conductivity (for details see [2,3,5]).

Results

Table 1 presents the results of measurements of the forehead surface temperature in the individuals we examined. As can be seen from this table, the control sample and the reconvalescents differ statistically significantly from each other. In particular, it turned out that individuals who had COVID-19 had an average forehead temperature significantly higher than in the control.

Forehead temperature in t °C	Control (n = 204) a	Reconvalescents (n = 47) b
33,0	1	
33,4	1	
33,6	1	
34,0	2	
34,2	2	
34,4	4	
34,6	5	
34,8	2	
35,0	6	
35,2	21	
35,4	38	
35,6	50	
35,8	48	
36,0	28	2
36,2	12	11
36,4	1	
36,6	1	14
36,8		4
37,0		3
37,2	1	5
37,4		4
37,8		2
38,2		1
39,0		1
Total	7972,4	1729,6
Statistics	$\chi^2 = 355$; df = 249; P < 0,0001;	
Mean number	**35,591±0,157**	**36,8±0,0975**
Statistics	$t_{a,b} = 14,469$; df = 249; P < 0,001;	

Table 1: Distribution of forehead temperature (t °C) in healthy individuals and reconvalescents who underwent COVID-19.

Table 2 presents the results of measurements of the surface temperature of the right palm of the individuals we examined. As can be seen from this table, the control sample and the reconvalescents differ statistically significantly from each other. In particular, individuals who have undergone COVID-19 have an average palm temperature significantly lower than in the control.

Palm temperature in t °C	Control (n = 204) a	Reconvalescents (n = 47) b
31,2	1	
31,4	1	
31,6	5	
32,2	1	
32,4	1	
32,6	2	
32,8	1	
33	2	8
33,2	3	16
33,4	6	6
33.6	10	
33,8	11	2
34	14	6
34,2	16	2
34,4	18	4
34,6	23	
34,8	24	1
35	17	1
35,2	24	
35,4	12	
35.6	18	
35,8	7	
36	3	
36,2	4	
37,2		1
Total	7749,9	1583,2
Statistics	$\chi^2 = 122$; df = 249; P < 0,0001	
Mean number	**34,59±0,257**	**33,685±0,211**
Statistics	$t_{a,b} = 6,234$; df = 249; P < 0,001;	

Table 2: Distribution of palm temperature (t °C) in healthy individuals and reconvalescents who underwent COVID-19.

Table 3 shows the distributions of the temperature difference (t °C) of the forehead and palm in healthy individuals and reconvalescents. As can be seen from the table, according to this characteristic, the control sample and the reconvalescents statistically significantly differ from each other. In particular, it turned out that in individuals who underwent COVID-19, the temperature difference between the palm and forehead was significantly higher than in the control sample.

Temperature difference between forehead and palm in t °C	Control (n = 204) a	Reconvalescents (n = 47) b
0	12	
0,2	20	
0,4	26	
0,6	31	
0,8	23	
1	22	
1,2	26	
1,4	20	
1,6	9	1
1,8	7	
2	7	1
2,2	3	1
2,4	4	2
2,6	1	1
2,8	4	6
3	1	12
3,2	1	13
3,4	1	6
3,6		1
3,8	1	1
4	3	
4,2	2	1
Total	248,3	142,5
Statistics	$\chi^2 = 166$; df = 249; P < 0,0001	
Mean number	**1,108±0,05294**	**3,031±0,0875**
Statistics	$t_{a,b} = 16,042$; df = 249; P < 0,001;	

Table 3: Distribution of the temperature difference (t °C) of the forehead and palm in healthy individuals and reconvalescents who have undergone COVID-19.

Thus, our studies have shown that individuals who were admitted to the hospital with COVID-19 have a low BHC. If this is really the case, then we can expect that: a) all individuals can get sick with COVID-19, regardless of the BHC level; b) this infection is most easily tolerated by individuals with high BHC and they rarely seek medical help; c) COVID-19 is hard to tolerate by individuals with low BHC and they are most often admitted to hospitals. However, we cannot say that individuals with a relatively high BHC compared to other patients recover more often from hospitalized patients, since we do not yet have data on the level of BHC among the deceased due to the ban on working in the "red zone", where COVID-19 patients are treated.

Discussion

Earlier we showed that on the population level: a) individuals in a population differ from each other on the level of BHC; b) individuals differ in BHC from different age groups, on the average human BHC level is steadily changed decreasing with age; c) weight, height, types of body constitution, pulse rate and level of arterial pressure do not effect on the variability of BHC in population; d) individuals suffering from alimentary obesity are characterized by extremely low BHC; f) the indigenous inhabitants of the low mountains and low geographical latitudes differ on average in higher BHC than the inhabitants of the highlands and high latitudes [2-5].

It is noteworthy that these results correspond to the data obtained in the study of the quantitative content of constitutive heterochromatin in the genome, which determines the level of human BHC, namely: a) at the population level, the amount of heterochromatin in the karyotype of men is usually greater than that of women [7]; b) the amount of chromosomal heterochromatin in different age groups is different, most of the heterochromatin material is present in the genome of newborns, and the smallest amount in the elderly [8-10] and c) the largest amount of heterochromatin is present in the genome of populations living permanently at low geographical latitudes, the smallest in the indigenous inhabitants of the Far North and highlands, and residents of temperate climates zones in this respect occupy an intermediate position [2,11].

As statistics show, most often indications for hospitalization were in patients over 75 years old, as well as people over the age of 65 and those who were obese. In the light of the above, related to the wide variability of the BHC level in individuals in the population, this circumstance could find a rational explanation. Therefore, for example, according to the principle of temperature homeostasis, excess heat must leave the body; otherwise, dispersing in tissues, it causes a rise in temperature that is incompatible with life. As heat cannot be used by the body as a source of energy necessary for useful biological work, removal of heat is apparently the most important task of thermoregulation, since only a few degrees are needed to prevent thermal death. If heat emission into the external environment ceases completely, dangerous events of overheating during complete muscular rest may develop in 3-4 hours in man; in mice the corresponding period takes about 40 minutes, while in small birds- only a quarter of an hour. During moderate muscular exercise these periods are several times shorter [12]. Thus, the organism is not a thermal "machine" and does not use heat to perform physiological work. Therefore, thermoregulation is mainly directed at preventing overheating of the organism, which in terms of biology is more dangerous [13].

Above said we want to emphasize that the level of BHC is most directly related to the ability of the human body to promptly and effectively remove excess heat outside his body [9,10,13]. Since the level of BHC in the population of elderly and obesity individuals is the lowest, it is easy to imagine how difficult it is to deal with an increase in body temperature and its effective elimination. It is no coincidence that the main symptoms of COVID-19 are fever, cough, and shortness of breath. In short, older and obesity people with low BHC will experience serious difficulties in removing excess heat outside the body.

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