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TAWAZUN-I-HARARAT (THERMOREGULATION) OF HUMAN BODY IN UNANI MEDICINE-A REVIEW

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ABSTRACT

Thermoregulation is the maintenance of a relatively constant core body temperature. *Tabi'at* is bestowed to everybody which is *Mudabbir* (supreme planner) of physiological functions. The tool of *Tabi'at* is *Hararat-i-Ghariziyya* through which all actions and reactions are accomplished. Being endothermic in nature it plans to remain in a narrow range of temperature despite wide variance with the external environment. The regulation of this action is achieved by involvement of multiple organs and organ systems. Hypothalamus in *Dimagh-i-Muqaddam* (forebrain) plays key role in this action. It involves receptors like skin, spinal cord, and blood temperature. *Hararat* (heat) and *Burudat* (cold) are perceived via these receptors. Based on the information received by these centre, *Ahkam* (instructions) are relayed to thermostatic centre of brain where decision is taken either for *Di'an-i-Hararat* (heat loss) or *Tawlid-i-Hararat* (heat genaration) as per set point through various activities. Heat is gained by *Hararat-i-Ghariziyya* (Innate heat), *Quwa Tabi' iyya* and *Riyazat* (Exercise), vasoconstriction, contraction of pili motor muscle, huddle position, shivering and lost by radiation, convection, conduction and evaporation. Unani philosophers have dealt with this phenomenon and have described the role played by *A 'da*-i-*Raisa* (vital organs) and

its subordinates. This review paper deals with approach of Unani philosophers in context of Thermoregulation.

KEYWORDS: Body Temperature; *Tabi'at* (Medicatrix Naturae)*; Hararat-i-Ghariziyya* (Innate heat); Thermoregulation; Unani Medicine.

1. INTRODUCTION

Since time immemorial, the human being is inquisitive to know the phenomenon happening inside and outside of the body. Hypotheses are postulated and theories are put forward to explain these happenings. Everything in the Universe is created from four basic constituents (*Arkan Arba'a)* i.e., fire, air, water and earth, which have different temperaments i.e. cold, hot, wet and dry respectively. So everything including the human body is having the properties of four basic constituents.[1,2,3] *Buqrat* (Hippocrates, 460-377 BCE) said that *Tabi'at* (Physic) is a managing power that works for the welfare of the human body involuntarily and unconsciously and is a source of all motion and rest.[4,5] Practically *Tabi'at* is considered as the supreme planner of our body.[6] *Ibn Nafis* (1210-1288 AD) said in other worlds *Tabi'at* is a power which, when found in a natural body itself becomes the first source for its motion and rest.[7] *Quwwat-i-Mudabbira-i-Badan* has been bestowed by such power up to certain limitations, can control and coordinate the body functions. When these limitations are crossed, *Tabi'at* is unable to control the functions. The temperament/constitution (*Mizaj)* of the person becomes abnormal. Due to *Mizaji* obligations, deviation in *Mizaj* results in functional abnormalities and consequently deformities happen.[8] Each individual's constitution has a self-regulating capacity or power, called *Tabi'at* or *Mudabbira*-i-*Badan* vis medicatrix naturae. Its function is to keep the factors of existence (*Umur Tabi'iyya)* in equilibrium.[9] The tool of *Tab'iat* is *Hararat*-i-*Ghariziyya* of all faculties (power) through which all physiological actions and reactions are accomplished.[10] If the innate heat is strong, the natural faculties can work through it, upon the humour and so affect digestion and maturation, and so maintain them within the confines of the healthy state.[11]

According to Thermodynamics, human beings are open system isothermal machine that works in non-equilibrium in which both matter and energy are exchanged.[12] Human calorimetry is unique because of its endothermic nature.[13] Being endothermic it plans to remain in a narrow range of temperature despite wide variance with the external environment. The regulation of this action is achieved by the involvement of vital organs and their subordinates, servant organs (*A'da-i-khadima).* Hypothalamus in the forebrain (*Dimagh-i-*

Muqaddam) plays a key role in the action. It involves receptors like skin, spinal cord, abdominal viscera, and blood temperature. Heat and cold are perceived via these receptors and instructions are relayed accordingly to the thermostat centre in the brain for thermoregulation. Normal core body temperature is around 37 °C and controlled within a narrow range (33.2–38.2 °C) and narrowing further when disregarding oral measurements in favour of rectal, tympanic or auxiliary measurements. There are normal fluctuations that occur throughout the day (circadian rhythm), throughout a month (menstrual cycle), and throughout a lifetime (ageing).[14] The Unani philosophers have established a linkage between the vital organs and their subordinates in explaining the mechanism of this prime important phenomenon of life.

2. METHODOLOGY

An extensive review was carried out to record all the available information in Unani Medicine literature on the concept of *Tawazun-i-Hararat* (thermoregulation) in the Urdu language including relevant books, periodicals, and indexed journals. Before the explanation of Unani concept of thermoregulation, related conventional literature is described here briefly.

3. Homeostasis

Homeostasis is achieved through feedback signals. Feedback is the process in which some proportion of the output signal is fed (passed) back to the input. There are two types of feedback, one is more frequent called negative feedback and the other less common is positive feedback.[15] If some factors become excessive or deficient, a control system initiates negative feedback, which consists of a series of changes that return the factor toward a certain mean value, thus maintaining homeostasis.[16] Thermoregulation operates on the principle of negative feedback. Deviations from a normal set point are detected by a sensor, and signals from the sensor trigger compensatory changes that continue until the set point are again achieved.[13]

3.1. Thermoregulation

Thermoregulation means core body temperature remains at a constant level despite wide variance with the external environment. For this food and clothes are used accordingly e.g., in the cold season, hot eateries are taken and warm clothes are put on, sunbath and hand-warming by fire are done and in summer vice versa. For thermoregulation, two things are necessary, one is the presence of hot blood and the other is the circulation of blood in the

body so that heat is constantly maintained. When blood goes to the skin, it becomes relatively cold and when it goes to liver it becomes relatively hot but when the blood purified by lungs goes to the left atrium, then its temperament becomes moderate.[17]

3.2 Temperature in different organs, age, sex and environment

Normal body temperature at the mouth, arms and vagina is 98-99 ^{0}F but in the axilla, it is 98 ^{0}F. Variation of temperature in a different part of the body is due to different blood volumes and also due to some other causes.[17] The testes are located in the dangling scrotum to maintain the temperature of these glands below the internal temperature of the body, although usually only about 2 °C below the internal temperature.[16] The hormonal input is an integrative part of reproduction, with the primary purpose of creating an environment most hospitable for conception and a developing foetus. These hormone effects on thermoregulation and also influence many other physiological systems, including body temperature itself.[18] Adults in comparison to old persons and young with respect to adults have 1 ^{0}F more temperature but thermogenesis capacity in old persons and youngs are weaker than adult i.e. why they are unable to tolerate cold. Although heat is regularly dissipated by skin and respiration and body is also affected by cold, despite these core body temperature remains constant at 37 ^{0}C (98.5 ^{0}F) How it happens? It is accomplished due to the balance between production and loss of heat.[17] The earth is inhabited by human beings in diverse atmospheric condition but everywhere the human body maintains constant core body temperature. The world's highest officially recorded average daily high temperature was 47 °C or 116.6 °F in a remote desert town in the Algerian Desert called Bou Bernous, at an elevation of 378 meters (1,240 ft) above sea level, and only Death Valley, California rivals it.[19,20] Oymyakon, Russia (-58 ^{0}C) holds the record for being the coldest inhabited place on earth.[21]

Table 1: Temperature Range and Short term non-lethal limit of human body.[16]

	Normal value	Normal range	Approximate short term non-lethal limit	Unit
Body temperature	98.4 (37.0)	98-98.8 (37.0)	65-110 (18.3-43.3)	^{0}F (^{0}C)

3.3.*Consequences to cross the normal limit*

Most important are the limits beyond which abnormalities can cause death. For example, an increase in the body temperature of only 11 ^{0}F (7 ^{0}C) above normal can lead to a vicious cycle of increasing cellular metabolism that destroys the cells.[16]

4. Concept of thermoregulation as per unani medicine

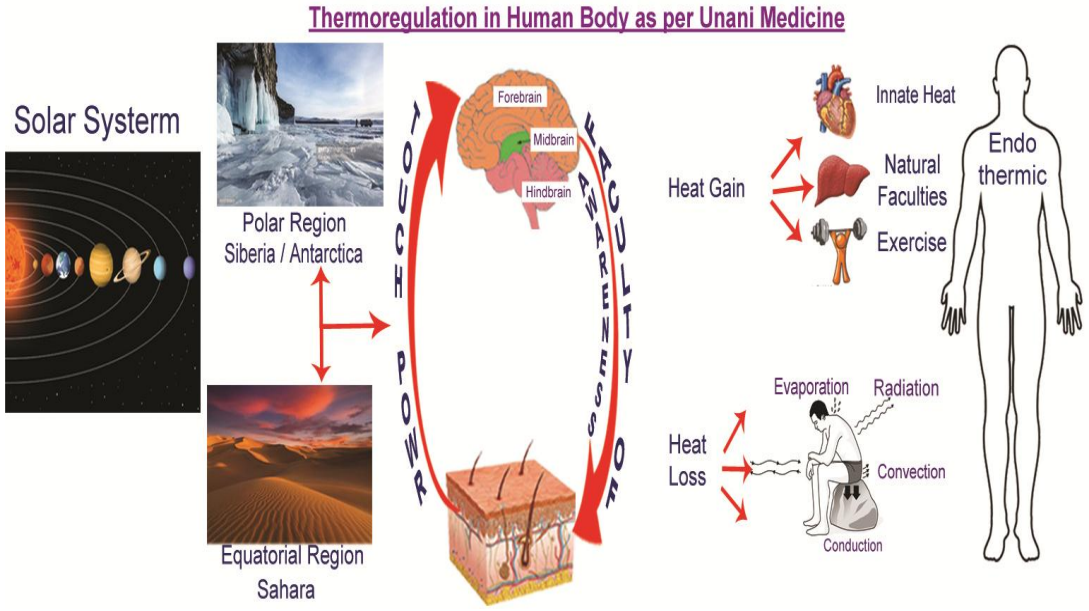

Fig. 1.

4.1. Heat production

As humans are endothermic homeotherms, we produce our body heat and can regulate our body temperature. Our high core temperature is achieved principally through heat production as a result of metabolism. Heat transfer always occurs down a thermal gradient (from hot to cold) through the processes of radiation, conduction, and/or convection.[14] Atmosphere, food and exercise influence body temperature. So body temperature increases itself 1-2 ^{0}F on moving from cold to hot places, on taking hot eateries or during exercise. *Hararat-i-Ghariziyya* which protects the body from infection remains in the body during the whole life. According to *Ibn Sina* (980-1037AD) and *Ibn Nafis* (1210-1288 AD), it is a fiery substance (*Jawhar-i-har)* which is given to the body at the time of quickening. From this substance, heat is produced in the body all time and transmits to the whole body via arteries. This substance remains constant up to the adult stage thereafter it gradually declines. So in the old stage body temperature decreases and finally this substance becomes very less which results in death. According to *Jalinus* (129-200 AD), this substance is a fiery element (*Unsur Nariya)* which remains present during the whole life. The modern theory also supports the Galenic view. The production of heat may be exemplified by the burning of a lamp whose physiology is well known. The inflammable matter, carbon, in the oil of lamp burns with the help of oxygen of the ambient air which produces light and heat. If the lamp is covered by cup or glass then it is put off due to discontinuing in oxygen supply. Likely this happens in

our body, when oxygen enters our body by lungs it reacts with the inflammable particle of food present in our body and produces heat and is distributed in the whole body. In our body, heat is produced by the oxidation of inflammable particles. Firstly heat is produced in the lungs by the oxidation of volatile matter and when oxygen reaches the organ then heat and energy are produced by the oxidation of inflammable matter produced by the regular dissolution of organs. Mostly heat is produced in muscles because it is approximately half of the total body weight. So oxygen is consumed here proportionately more and accordingly, heat is produced especially during exercise. That is why after exercise, heat is increased. Muscle is followed by liver and secreting glands in the production of heat.[17] A variety of basic chemical reactions contribute to body heat production at all times. Ingestion of food increases food production but a major source heat is the contraction of skeletal muscle. Heat production can be varied by endocrine mechanisms in the absence of food intake or muscular exertion.[13]

4.2. *Heat Loss*

Most heat is lost by the skin in the form of radiation. On exposure to cold, heat is transmitted to that object. Also, it dissipates due to sweating and vapours. It is also lost by respiration and excreta. So skin has prime importance in thermoregulation followed by bronchi and air tubules.[17]

As humans are often the hottest objects in a given environment, the normal direction of heat transfer is from the body to the surroundings. However, as core temperature rises, heat loss through evaporation becomes the primary mechanism of heat dissipation. The processes by which heat is lost are vasodilatation and sweating.[14] According to Unani philosophers, skin is an important sensor of cold and hot of the external environment. Hot air dilates the pores of the skin and cold air constricts the pore of skin.[7] *Ibn Nafis* (1210-1288 AD), has described the role of the hunger reflex in thermoregulation. He said that cold air increases hunger and confronts the *Hararat-i-Ghariziyya* (innate heat) in the body [7]. *Hararat-i-Ghariziyya* does not exist alone; a *Rutubat* is always accompanied with it and that is blood.[22,23,24] Heat is one of two factors to which Avicenna attributes the existence of life; he states, “Life is sustained by heat, and grows by moisture”.[25] The innate heat, therefore, is the instrument of (human) “nature” for combating the injurious action of extraneous or foreign heat.[11]

Skin is a sensory organ for heat and cold. It is perceived by touch power (*Quwwat Lamisa)* and this sensation is relayed to the brain by common sense (*Hiss Mushtarak)*. The origin of

the action lies in the forebrain (*Dimagh-i-Muqaddam).*[26] As skin has prime importance in heat protection (*Hifz-i-Hararat)* similarly it plays an important role in *Tawazun-i-Hararat*.[17]

4.3. *Relation between body temperature and nervous system*

Thermoregulation is achieved by nerves. Its first evidence is that when any organ is denervated then the temperature of that organ remarkably falls. That is why after denervation in hemiplegia, the temperature of the organ falls. Second is that when death happens due to the bigger shock of the nervous system or due to its excision, body temperature rapidly falls. There is a change in the flow of heat in different psychic expression *(Infi'alat-i-Nafsaniyya).* In anger and happiness, the face becomes hot and red. In fear and fright face becomes yellow.[17]

4.4. *Role of Brain*

The origin of *Quwa Nafsaniyya* (psychic power/mental faculties) is the brain. It has two kinds, one is *Quwa Mudrika Bayruni* (external perceptive powers) whose centres are sensory and lies outside the brain e.g., eye for vision, ear for hearing and balance, nose for olfaction, tongue for taste and skin for touch, and another is Internal perceptive powers (*Quwa Mudrika Andruni)* which lies inside the brain e.g. faculty of awareness (*Quwwat Mutakhaiyila)*, power of justification (*Quwwat Mufakkira)* and faculty of memory (*Quwwat Mutazakkira).*[26] Faculty of apprehension (*Quwwat Wahima)* is the king of all powers of the brain and it is found in the whole brain. Its centre lies in the posterior part of the midbrain (*Batn-i-Ausat).* After the perception of sensory organs and integration in *Batn-i-Muqaddam*, it relays instructions as per situation.[26]

4.5. Role of heart

Blood provides *Hararat-i-Ghariziyya* to various organs through the arteries arising from the heart.[7,26] One of the life-saving functions of the blood is that it keeps the body warm.[7] This is also stated in modern physiology that blood regulates body temperature through high specific heat, high thermal conductivity, high latent heat of vaporization, and quick flow.

4.6. Role of Liver

The liver is the kitchen of the body where food is metabolically processed. It is the originator of nutritive faculty.[26] It maintains the quantity of *Hararat-i-Ghariziyya* by replenishing the depleted amount of *Hararat-i-Ghariziyya*.

4.7. *Site and Temperament of vital organs facilitating Thermoregulation*

For thermoregulation, organs of the body have individual and specific temperaments such as the temperament of the brain is cold and wet. Nerves originating from the brain have regular actions and reactions which result in heat. For moderation of heat, the brain needed to be cold so that temperature may be balanced. If it would not happen, the site of *Quwwat Mutakhaiyla, Quwwat Mutafakkira,* and *Quwwat Mutazakkira* were burnt out due to the heat generated by excessive actions and reactions. Being temperamentally cold, the brain also helps to moderate the heat of pneuma (Ruh) originating from the heart passing towards the brain via both cerebral arteries. In the case of heart, both its site and temperament help to understand its role in thermoregulation. The heart is situated in the middle of the thorax tilted slightly towards the left so that heat may be distributed everywhere in the body. Another physiological advantage is that liver may be kept at a distance to protect it from the heat of the heart as temperamentally both liver and heart are hot. This management also helps temperamentally cold spleen, to be closer with the heart so that it may get heat.[2]

5. Role of *Hararat-i-Ghariziyya* in thermoregulation

5.1. Relation between Hararat-i-Ghariziyya and Tabi'at

Hararat-i-Ghariziyya is considered as a tool of *Tabi'at*. It helps *Tabi'at* in maintaining all bodily functions that are performed by various faculties. Each *Quwwat* requires *Hararat-i-Ghariziyya* for its functions. In case of any deviation in this heat, *Tabi'at* tries to bring back the moderate *Hararat-i-Ghariziyya* so that all the *Quwa* can perform their functions properly.[2] *Majusi* says that the state of the body is under the control of *Mizaj Tabi'i*.[1] He also says that air is the strong cause among other causes which influences the changes in *Mizaj Tabi'i*. Respiration is utmost for survival and it is taken in the air so it necessitates that body states should be under the control of *Mizaj* of the ambient air.[1] If the ambient air is hot, the tactus of the body will be hot and if the ambient air is cold the tactus of the body will be cold[1]. Therefore, the tools of *Tabi'at* are *Mizaj* and *Hararat-i-Ghariziyya* and with the help of these tools, *Tabi'at* maintains the equilibrium of the body. So, the direct relationship between *Mizaj*, *Hararat-i-Ghariziyya*, and *Tabi'at* exists.[2]

5.2. Death and Hararat-i-Ghariziyya

Jalinus (Galen, 129-200 AD) says that death is due to immoderate *Hararat-i-Ghariziyya* which is vitiated by internal and external causes. Internal causes include *Su-i-Mizaj* (abnormal temperament) of organs such as heart, brain, liver, lungs, blood clotting,

congestion, hyperpyrexia, Iron deficiency anaemia, intake of a poisonous and sedative group of drugs such as *Afiyoon* (Opium), *Shokran* (Hemlock), *Farfiyoon* (Resin spurge), *Azraqi* (Strychnos nux-vomica), etc. External causes include sudden expelling out of *Hararat-i-Ghariziyya* to the exterior e.g. haemorrhage, sudden movement of *Hararat-i-Ghariziyya* to the interior of the body e.g. horrible and frightful scene, sunstroke, respiratory disturbances, hanging, etc.[1] When *Hararat-i-Ghariziyya* weakens, *Rutubat-i-Ghariziyya* weakens and vice versa.[29] According to *Ibn Sina* (Avicenna, 980-1035 CE), there is sometimes the "abnormal heat" (*Hararat Ghareba*) that is generated due to toxins, hypoxia, or weakness of the innate heat and results in putrefaction. The abnormal heat is a state where the innate heat is not strong enough to carry out the normal functions to their completion. *Ibn Sina* (Avicenna, 980-1035 CE), also states, "After the period of youth, the heat starts to diminish due to the decline in moisture, and in agreement with the internal innate heat and support of physical and psychological actions that are needed, therefore, in the absence of a natural reversal, all bodily functions reach their end".[25]

6. DISCUSSION

Our Skin is the 2-m^2 large organ that serves as a barrier between our internal and external environments and protects the former from diverse unfavourable factors of the latter, thus allowing us to maintain homeostasis. The skin is also the largest sensory organ of our body and it further contributes to homeostasis by sensing various disturbances occurring at the border of two environments, including thermal disturbances and triggering defence responses. Amazingly there is no agreement on which thermal disturbances are detected by skin, external or internal.[27]

According to Unani Concept, *Tabi'at* is the supreme controller of all physiological actions. All the actions and influences are caused by *Hararat-i-Ghariziyya* which is supplied from pneuma that travels in blood vessels.[28] According to Galen, innate heat is the most essential element in the body which facilitates the existence of life. It is housed within the heart from where heat is distributed to the rest of the body.

Ismail Jurjani (12th century AD) says that the heart is the sole originator of *Quwa Haywaniyya* (vital power) and *Hararat-i-Ghariziyya*. The human body manifests life through *Quwa Haywaniyya* and warmth due to *Hararat-i-Ghariziyya.* In every organ of the body both (*Quwa Haywaniyya* and *Hararat-i-Ghariziyya*) reach out simultaneously. Without the support of *Quwa Haywaniyya*, other faculties could not get access to distant organs. The well

being and comfort of the human body are the result of the normal functioning of these two faculties otherwise physiological actions may be disturbed. Therefore the manifestation and reflection of all the faculties are expressed by the function of the heart.[2] *Majusi* (Haly Abbas, 930-994 AD) considers that existence and sustenance of life depend upon *Arwah (*pneumas) and the continuation of *Arwah* depends upon moderate *Hararat-i-Ghariziyya* and proportionate *Humours*.[1,29] *Majusi* (Haly Abbas, 930-994 AD) also says that *Hararat-i-Ghariziyya* is superior to respiration as the great advantage of respiration is to make *Hararat-i-Ghariziyya* moderate. Hence respiration is the safeguard to *Hararat-i-Ghariziyya*.

Thermoregulation is so important that without which all the metabolic activity will be collapsed. Considering its importance, *Tabi'at* makes it necessary to involve all the three *Vital organs* and their *A' da-i-Khadima* (servants organs) for existence, sustenance, and propagation of life. Heart, the originator of *Quwa Haywaniyya*, is the storekeeper of *Hararat-i-Ghariziyya* which is a tool of *Tabi'at.* It coordinates in the distribution of heat throughout the body as per need and helps in establishing homeostasis. Liver, the originator of nutritive power, plays a paramount role in the maintenance of the required quantity of *Hararat-i-Ghariziyya* by hobnobbing with *Tabi'at*, without which the depleted amount of *Hararat-i-Ghariziyya* could not be replenished. Brain, the originator of all sensory and motor power, plays a key role in regulating this mechanism by relaying the instructions to the subordinate nerves as per the need where the decision is taken either for loss or gain of heat.

7. CONCLUSION

The earth is inhabited by human beings in diverse atmospheric conditions from Siberia to Sahara, from extreme cold to extreme hot but everywhere the human body maintains a constant core body temperature. Being an endothermic human body plans to remain in a narrow range of temperature despite wide variance with the external environment. It is needed to maintain the concentration of various electrolytes and to keep the body in good health. Unani philosophers have described the thermoregulatory mechanism by elaborating on the role of *Tabi' at* and *Hararat-i-Ghariziyya* through which all physiological functions are accomplished. They have described the role of vital organs and *A'da-i- Khadima* in carrying out this task. They have also described the role of the hunger reflex played in this mechanism. These explanations may pave the way to understand the objective parameter of this physical entity and consequences to cross the normal range viz. hypothermia, hyperthermia and death.

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