IMPORTANCE OF THERMOREGULATION AND THERMOGENESIS IN DIABETES FROM THE AVENUE OF KRIYA SHARIR.

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ABSTRACT

Background: Ayurvedic treatment for diabetes is multidimensional. By knowing it completely and implementing it perfectly, glycemic control and prevention of its precarious complications is possible. Though many Ayurvedic medicines, diet and exercises scientifically proved beneficial in diabetes treatment, some basic principles are still unexplained due to physiological difference of both sciences. Thermoregulation and Thermogenesis are comparatively new aspects related to diabetes. However not enough research has investigated on its pertinence in diabetes treatment. Objective: The study aims to explore concepts of thermoregulation, thermogenesis and diabetes from Ayurvedic perspective. Methods: Classical Ayurvedic texts were searched for prameha. Various research articles and recent studies were searched for the reference of thermoregulation, thermogenesis, hyperlipidemia, insulin and diabetes. Results: The fundamental principle behind each disease is agnimandya i.e. low digestive fire. Among other dushyas of diabetes meda and kleda are two main important factors to be considered. To improve medo dhatwagnimandya in diabetes all the treatment described like aatap sevan, bare foot walking, gaadh udvartan, abhyanga, snana, jalavseka, laghoo aahar and Ushna Veerya, Katu and Tikta Vipaki medicines indirectly helps in thermoregulation and thermogenesis. The same treatment is also observed beneficiary in obesity and hyperlipidemia. Conclusion: So it can be concluded that thermoregulation and thermogenesis are the distinctive factors of Ayurvedic treatment for diabetes since centuries. Also this study will provide a new perspective for conducting clinical trials.

KEYWORDS: Thermoregulation, Thermogenesis, Diabetes, Hyperlipidemia.
INTRODUCTION
Diabetes is a disease of lifetime. Avoidance of its precarious complications is one of the important objectives of the recent researches. Treatment of diabetes always demands to reduce obesity and hyperlipidemia which are often associated with insulin resistant diabetes. Individuals with diabetes irrespective of its type have been reported to have impaired skin blood flow and sweating responses during heat and cold exposure. They are more sensitive to environmental changes. Also higher fasting plasma glucose levels are observed in the winter and at extreme cold and hot temperature. Approximately all enzymatic reactions in the human body are thermogenic. Thermogenesis improves insulin sensitivity by increasing the capacity for fat oxidation.

Thermoregulation and thermogenesis are not described in Ayurvedic physiology. But daily Ayurvedic regimen described for diabetes can be called as thermogenic and thermoregulatory in action according to modern physiology. Precise diet, exercises and medicines described in the treatment were never just aimed for glycemia but to prevent complications and to reduce causative factors like obesity and hyperlipidemia.

Though benefits of thermoregulation and thermogenesis are studied its utilization in the treatment of diabetes is yet inadequate. Hence the study is selected to evaluate the importance of thermoregulation and thermogenesis in diabetes from the avenue of Kriya Sharira.

AIMS AND OBJECTIVES
To evaluate the importance of thermoregulation and thermogenesis in diabetes from the avenue of Kriya Sharira.
To explore the significance of Ayurvedic treatment for diabetes in the management of obesity and hyperlipidemia.

MATERIALS AND METHODS
Various search engines like Medline, Google scholar, Science direct, Pub med were searched for recent studies on thermogenesis and thermoregulation. The experimental, clinical studies found supportive of Ayurvedic management in diabetes, obesity, dislipidemia were reviewed. Classical Ayurvedic texts were searched for the reference of specific treatment of diabetes.
LITERARY STUDY

Thermoregulation

Thermoregulation is a process that allows your body to maintain its core internal temperature. All thermoregulation mechanisms are designed to return your body to homeostasis. The skin, the subcutaneous tissues and fat act together as a heat insulator for the body. The insulation beneath the skin is an effective means of maintaining normal core temperature. A high skin blood flow causes heat to be conducted from the core of the body to the skin with great efficiency. Whereas reduction in the rate of skin blood flow can decrease the heat conduction from the core to very little.[5] Obesity is a condition associated with high body heat content. Several physiologic changes that accompany the development of obesity tend to increase heat production or impede heat loss. Resting metabolic heat production is significantly greater in obese than in lean individuals.[6] To maintain homeostasis, the body uses four mechanisms of heat exchange: conduction, convection, radiation, and evaporation. Heat flows from a higher concentration to a lower concentration; therefore, rate of heat exchange of each of the mechanisms varies according to the temperature and conditions of the environment.

1. **Evaporation** – Body loses heat through sweating and respiration. Aerobic exercises increase respiration and perspiration leads to major heat loss. During intense exercise about 85 percent of the heat is lost by the body through evaporation.

2. **Convection** – Heat loss by air or water moving across the skin surface. Body’s heat is lost through convection is about 15 percent.

3. **Conduction** – heat loss by direct contact with cool object like water or air. About 2 percent of body’s heat is lost through air conduction. Water causes more heat loss than air.

4. **Radiation** – About 60 percent of the heat is lost by the body through radiation when the environmental temperature is cooler than body temperature.

**Heat acclimatization:** Temperature signals from the peripheral areas like skin of the body, alter the set point of the hypothalamic temperature control center. A person expose to heat for several hours each day while performing a reasonably heavy work load will develop increased tolerance to hot and humid conditions in 1 to 3 weeks. The most important physiological changes that occur during acclimatization process are an approximately two fold increase in the maximum rate of sweating, an increase in plasma volume, and diminished loss of salt in the sweat and urine to almost none.[7]
Ayurvedic perspective: Pitta controls rather regulate the ushna (core body temperature) of the body. It is responsible for all the metabolic processes at the cellular level and digestion at the level of the gut. Pitta is the contributor of ushna guna (warmth) to the body. The stimulator (preraka) of pitta is vata. Vata, in association with pitta and kapha, maintains the normal core body temperature by controlling the heat regulating system and balancing the sheeta and ushna guna.[8]

Ayurvedic physiology of Perspiration: Jatharagni (digestive fire) is located in amashaya in the form of pachak pitta.[9] Ushma of agni is brought to the skin by samana vaayu.[10] Vyan vayu is responsible for the control of sweat glands and opening and constriction of pores[11] Sweda is related with pitta with ashrayashrayi bhava. Dravata and snigdha of sweda is due to kapha and it is the mala of meda. Meda is the main dushya among the ten dushyas of diabetes. Therefore abnormal increase of sweating is seen in medodushti.

In medodushti which is the primary cause of diabetes and obesity, samana vayu is clogged by meda. Hence ushma of jatharagni from the stomach is unable to reach to the skin. Because opening and closing of skin pores for perspiration is controlled by vyana, perspiration occurs as a response to the environment. But in absence of ushma of jatharagni, skin is always cold to touch in diabetes. Cold and clammy skin is the sign of type 1 diabetes according to modern science. Secondly agni clogged by meda in the stomach increases the appetite which leads to over eating and ultimately results in obesity and other metabolic diseases like hyperlipidemia.[12] Swedana is one of the important treatments described in Shadopkramas for the treatment of Kapha and Vata ailments.[13] Vyayama and aatap sevana are the types of niragni swedana(non thermal sudation)[14] advised for diabetes which is beneficial in type 2 diabetes.[15] But direct contact of steam or heat is contraindicaded.[16]

Thermogenesis: Thermogenesis is a metabolic process during which body burns calories to produce heat. It is used in weight reduction therapy by increasing fat oxidation in skeletal muscles. Current diabetic treatment is unable to increase fat oxidation.

It is classified as.
1. Exercise- associated Thermogenesis (EAT).
2. Non exercise activity- induced Thermogenesis (NEAT)
3. Diet- induced Thermogenesis (DAT)
Protein and alcohol fraction of the diet are important determinants of diet induced Thermogenesis\[^{17}\]. Increase of insulin sensitivity by fat oxidation is the target of Thermogenesis in the treatment of diabetes. Herbal ingredients increase energy expenditure and reduce body fat.\[^{18}\] Consumption of spiced food or herbal drinks helps in greater Thermogenesis, fat oxidation and satiety.\[^{19}\]

**Specific diabetes treatment in Ayurveda:** this includes certain exercises, diet, powder massage and medicines. *Adhwa (walking):* Utmost importance is given to walking. It is not the part or supportive treatment but the only treatment advised for economically poor individuals to control the disease. Walking is proved more protective than running.\[^{20}\] Post meal slow walking reduces postprandial glycemia.\[^{21}\] *chhatra, padatra rahito* means bare foot and without umbrella walking of a distance of 100 yojanas(800 miles) is suggested\[^{22}\] Bare foot walking significantly reduces peak planter pressure on front and rare foot in diabetes.\[^{23}\] Peripheral neuropathy, a serious complication of diabetes, decreased muscle strength and obesity are associated with walking.\[^{24}\] Walking without umbrella can help in acclimatization of heat.\[^{25}\] It may increase sensitivity of sweating mechanism to reduce the heat stress. Heat stroke depends on lack of heat exposure and acclimation of heat.\[^{26}\]

*Aatap sevan* is a type of *niragni swedana* (non thermal sudation) very specifically told for *kapha* with *medodushti* ailments.\[^{27}\]

*Vyayama*(exercise): For diabetes, specific types of exercises are suggested according to the season and *bala*(strength) of the individual. Advice of *salilashaye khadet* (digging of well/pond)\[^{22}\] gives the idea of intensity, duration and posture of the exercise. Specific posture can stimulate the pancreas to increase the capacity of insulin production\[^{28}\] *niyudha, krida, gaja arohan and haya arohan* are some other intense exercises were suggested.\[^{29}\] In obesity and diabetes *vyayama, aatapa sevana* should be done in *shishir rutu*(winter season).\[^{30}\] Intense exercise or increased duration of exercise may control fasting blood sugar which increases during winter.\[^{2}\] Two important benefits of exercise are *sheeta di sahishnuta*(heat acclimatization) and *sthiri bhavati mamsa*(muscle strength) which may help in prevention of neuropathy.

*Pragaadh udvartana* (deep or prolonged powder massage with medicines) one more specific treatment for diabetes improves peripheral blood circulation, opens the sweat gland pores\[^{31}\] reduces or removes meda, *kapha* and gives strength to the muscles and skin. Skeletal muscle
blood flow increases the glucose uptake and improves long term glycemic control.[32] Connective tissue massage improves blood circulation and slows the progression of peripheral arterial disease.[33]

**Jalawaseka:** means sprinkling of water.

**Snana:** daily bath is also advised as a daily regimen to reduce sweda.[34] Avoidance of snana is one of the causative factors of diabetes.[35] Snana and udvartana with ruksh dravyas are lekhaneyya and kaphaghna.[36]

Charaka said a healthy person is that who can tolerate hunger, thirst, coolness and heat of the climate.[37]

**Diet:** Arishta pan (form of alcohol) is advised for diabetes. Arishtas are meda and kapha har and also swedojanak.[38] Types of soups made from Yava (barley) for diabetes mixed with spices like shunthi, marich, ajmoda, pipali, hingu, chitraka are advised.[39] Yava is described in swedopaga (adjuvant in sudation therapy) mahakashaya.[40] Types of medicinal oils, ghees, roasted flesh and soups of jangal birds and animals are also suggested.

**Medicines:** As diabetes is a kapha dominant disease, use of katu, tikta and ushna veerya dravyas in the treatment, are more. Which are also effective in obesity because of the common dushya meda.[41] Ushna veerya dravyas decreases basal metabolic rate.[42] Many of the herbs mentioned in medohara Ganas possess hypolipidemic as well as hypoglycemic activities.[43]

**DISCUSSION**
The ultimate aim of diabetes treatment is to normalize the vitiated doshas. Kapha dosha and meda and kleda are the important dushyas among other dushyas. Hence Ayurvedic treatment for diabetes is very specific. Tikta, katu and ushna veerya dravyas are used to reduce kapha and meda. And to reduce kleda, swedajanak ahar, vihar and medicines are suggested. Because of the common dushya meda, most of the treatment is also effective in obesity. Some medicines are also hypolipidemic in action. It is observed that specific treatments are thermoregulatory in action. The daily regimen advised can effectively dissipates heat from body and also check the complications related with heat or cold stress. Bare foot walking, walking under the sun without umbrella, digging of well or pond are the specific treatments
told for heat acclimatization. Different types of exercises suggested are individualized and with specific posture and gradation of intensity.

**Table 1: Thermo regulatory action of Ayurvedic treatment.**

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<tr>
<th>Convection</th>
<th>Conduction</th>
<th>Radiation</th>
<th>evaporation</th>
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<tbody>
<tr>
<td>Open air exercises like digging of well</td>
<td>Sprinkling of water</td>
<td>Bare foot walking</td>
<td>Aasava and Arishtapan</td>
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<tr>
<td>Bath</td>
<td>Walking without umbrella</td>
<td>Digging of ponds or well</td>
<td>Types of intense sports</td>
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**Table 2: Thermogenetic action of ayurvedic treatment.**

<table>
<thead>
<tr>
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<th>NEAT</th>
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<tr>
<td>Walking</td>
<td>Powder massage</td>
<td>Yava, katu tikta rasa diet mixed with spices</td>
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<tr>
<td>Types of intense sports</td>
<td>Aatap sevan</td>
<td>Aasava and Arishtapan</td>
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<tr>
<td>Digging of ponds or well</td>
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<td>Medicinal oils and Ghees</td>
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High protein diet in the form of medicinal oils and *ghees*, and eating flesh is prominently thermogenic. Use of barley not only reduces weight but also acts as satiety food.
Application of medicinal powders are advised as pragaadha application, means either deep or prolonged application is expected. It increases peripheral blood circulation and also heat acclimatization is achieved by muscle strengthening. Stimulation of peripheral nerves checks peripheral neuropathy. Also it is an effective treatment of obesity. Though walking is told for every diabetic individual, exercise is advised to be done judiciously according to the type 1 and type 2 diabetes. Walking is the most economic exercise advised for deprived individuals also suggests the prolongness of disease and importance of exercise in diabetes. Tikta rasa being laghu and ruksha reduces vitiation of kapha and medodushti. It is also deepaniya and pachaniya which improves the jathargnimandya. katu rasa exerts similar effect on kapha and medodushti by its laghu, ushna, and ruksha gunas. Thus all the suggested treatment of diabetes simultaneously takes care of obesity and other metabolic disorders like hyperlipidemia. Also it is thermoregulatory and thermogenic in action.

CONCLUSION
It is concluded that thermoregulation and Thermogenesis is the fundamental part of the Ayurvedic treatment in diabetes as a daily regimen. It considers both type 1 and type 2 diabetes and also helps in reduction of weight as well as hyperlipidemia. Clinical research on thermogenic action of diabetic treatment should be done with this new perspective.

REFERENCES


