

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

Jadhav Sangeeta Sanjay\* and Waghulade Hemangini Sanjay

School of Ayurveda, D.Y. Patil University, Nerul, Navi Mumbai.

Article Received on  
26 Dec. 2017,

Revised on 15 Jan. 2018,  
Accepted on 04 Feb. 2018  
DOI: 10.20959/wjpr20184-11002

### \*Corresponding Author

**Dr. Jadhav Sangeeta  
Sanjay**

School of Ayurveda, D.Y.  
Patil University, Nerul, Navi  
Mumbai.

### 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.<sup>[1]</sup> 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.<sup>[2]3</sup>

Approximately all enzymatic reactions in the human body are thermogenic.<sup>[3]</sup> Thermogenesis improves insulin sensitivity by increasing the capacity for fat oxidation.<sup>[4]</sup>

Thermoregulation and thermogenesis are not described in Ayurvedic physiology. But daily Ayurvedic regimen described for diabetes can be called as thermogenic and thermo regulatory 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 thrmogenesis 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.<sup>[5]</sup> 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.<sup>[6]</sup> 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 exposed 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.<sup>[7]</sup>

**Ayurvedic perspective:** *Pitta* controls rather regulate the *ushma* (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*.<sup>[8]</sup>

**Ayurvedic physiology of Perspiration:** *Jatharagni* (digestive fire) is located in *amashaya* in the form of *pachak pitta*.<sup>[9]</sup> *Ushma* of *agni* is brought to the skin by *samana vaayu*.<sup>[10]</sup> *Vyan vaayu* is responsible for the control of sweat glands and opening and constriction of pores<sup>[11]</sup> *Sweda* is related with *pitta* with *ashrayashrayi bhava*. *Dravata* and *snigdhatata* 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 vaayu* 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.<sup>[12]</sup> *Swedana* is one of the important treatments described in *Shadokramas* for the treatment of *Kapha* and *Vata* ailments.<sup>[13]</sup> *Vyayama* and *aatap sevana* are the types of *niragni swedana*(non thermal sudation)<sup>[14]</sup> advised for diabetes which is beneficial in type 2 diabetes.<sup>[15]</sup> But direct contact of steam or heat is contraindicated.<sup>[16]</sup>

**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<sup>[17]</sup> 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.<sup>[18]</sup> Consumption of spiced food or herbal drinks helps in greater Thermogenesis, fat oxidation and satiety.<sup>[19]</sup>

**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.<sup>[20]</sup> Post meal slow walking reduces postprandial glycemia.<sup>[21]</sup> *chhatra, padatra rahito* means bare foot and without umbrella walking of a distance of *100 yojanas*(800 miles) is suggested<sup>[22]</sup> Bare foot walking significantly reduces peak planter pressure on front and rare foot in diabetes.<sup>[23]</sup> Peripheral neuropathy, a serious complication of diabetes, decreased muscle strength and obesity are associated with walking.<sup>[24]</sup> Walking without umbrella can help in acclimatization of heat.<sup>[25]</sup> It may increase sensitivity of sweating mechanism to reduce the heat stress. Heat stroke depends on lack of heat exposure and acclimation of heat.<sup>[26]</sup>

*Aatap sevan* is a type of *niragni swedana* (non thermal sudation) very specifically told for *kapha* with *medodushti* ailments.<sup>[27]</sup>

**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)<sup>[22]</sup> gives the idea of intensity, duration and posture of the exercise. Specific posture can stimulate the pancreas to increase the capacity of insulin production<sup>[28]</sup> *niyudha, krida, gaja arohan and haya arohan* are some other intense exercises were suggested.<sup>[29]</sup> In obesity and diabetes *vyayama, aatapa sevana* should be done in *shishir rutu*(winter season).<sup>[30]</sup> Intense exercise or increased duration of exercise may control fasting blood sugar which increases during winter.<sup>[2]</sup> 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<sup>[31]</sup> 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.<sup>[32]</sup> Connective tissue massage improves blood circulation and slows the progression of peripheral arterial disease.<sup>[33]</sup>

**Jalawaseka:** means sprinkling of water.

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

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

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

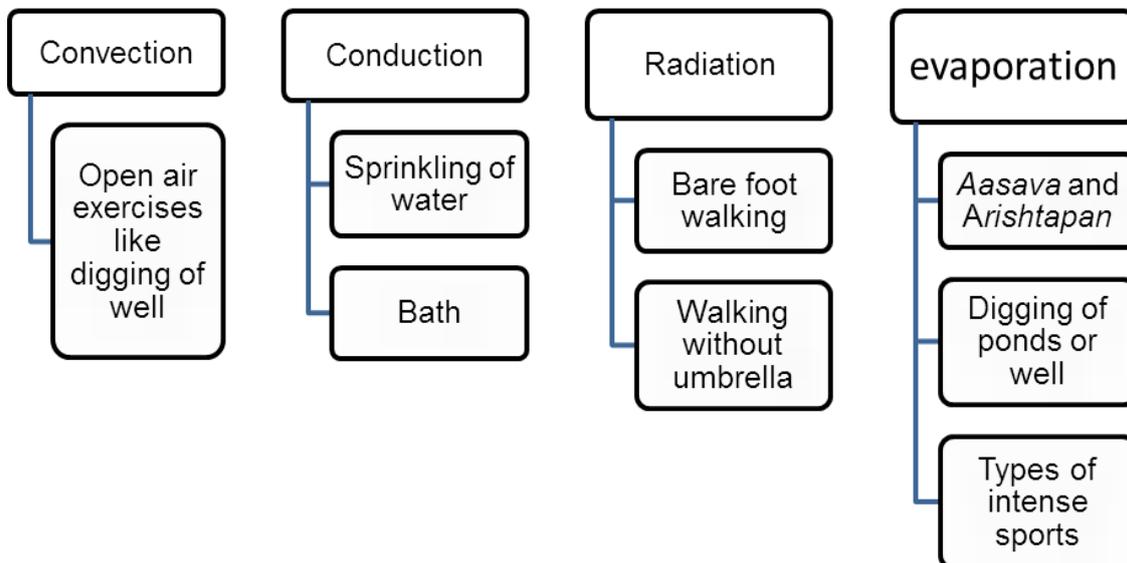
**Medicines:** As diabetes is a *kapha* dominant disease, use of *katu, tikta and ushna veerya dravyas* in the treatment, are more. Which are also effective in obesity because of the common *dushya meda*.<sup>[41]</sup> *Ushna veerya dravyas* decreases basal metabolic rate.<sup>[42]</sup> Many of the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

## DISCUSSION

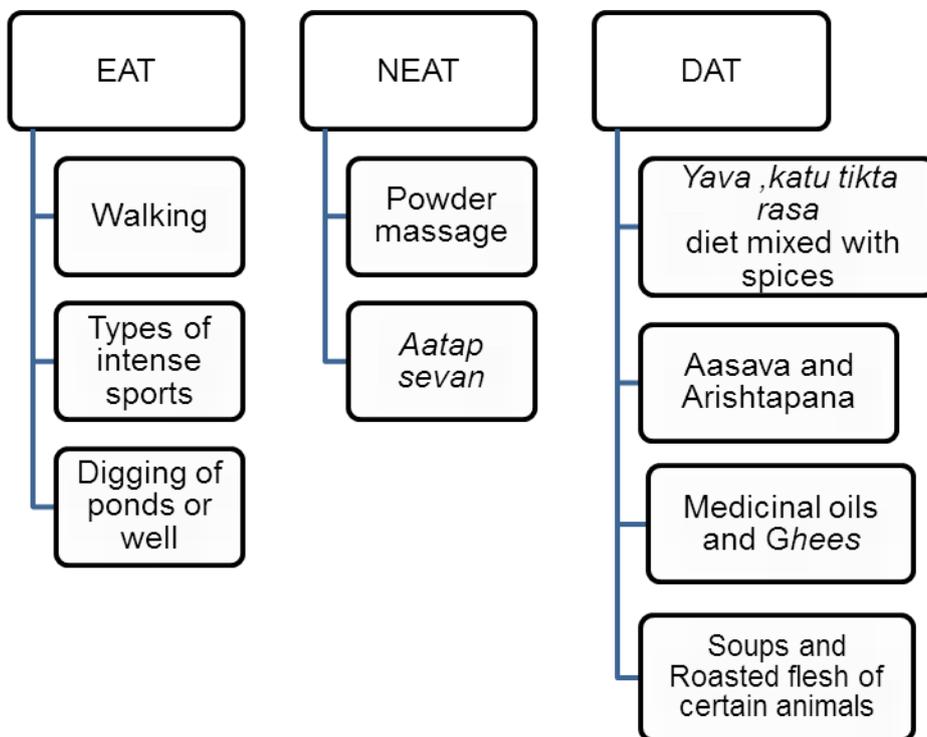
The ultimate aim of diabetes treatment is to normalize the vitiated *doshas*. *Kapha dosha* and *meda* and *kleda* are the important *dushyas* among other *dushyas*. Hence Ayurvedic treatment for diabetes is very specific. *Tikta, katu and ushna veerya dravyas* are used to reduce *kapha* and *meda*. 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.**



**Table 2: Thermogenetic action of ayurvedic treatment.**



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

1. Glen P Kenny, Ronal J Sigal and Ryan Mcginn. Body temperature regulation in diabetes. *Temperature* (Austin), 2016. Jan Mar; 3(1): 119-145  
doi: 10.1080/23328940.2015.1131506.
2. Li S, Zhou Y, Williams G, Jaakkola J J, Ou C, Chen S, Yao T, Qin T, Wu S, Guo Y. Seasonality and temperature effects on fasting plasma glucose: A population based longitudinal study in China. *Diabetes Metab*, 2016 Sept; 42(4): 267-75. doi: 10.1016/j.diabet.2016.01.002. Epub 2016 Feb 3.
3. Yu -Hua Tseng, Aaron M, Cype S S, C Ronald Kahn. Cellular Bioenergetics as a target for obesity therapy *Reviews*, 2010; 9: 465-81.
4. Arch J R. Thermogenesis and related metabolic targets in anti diabetic therapy. *Handb Exp Pharmacol*, 2011; (203): 201-55 doi :10.1007/978-3-642-17214-4-10.
5. Arthur C. Guyton, John E. Hall. *Body Temperature, Temperature regulation, and Fever*, William Schmitt, *Textbook of Medical Physiology*, Philadelphia; Elsevier Saunders, 11<sup>th</sup> Edition, 2006; 890.

6. David M Savastano, Alexander M Gorbach, Henry S Eden, Sheila M Brady, James C Reynolds and Jack A Yanovski. Adiposity and human regional body temperature. *Am J Clin Nutr*, 2009 Nov; 90(5): 1124-1131. doi 10.3945/ajcm.2009.27567.
7. Arthur C. Guyton, John E. Hall. *Body Temperature, Temperature regulation and Fever*, William Schmitt, *Textbook of Medical Physiology*, Philadelphia; Elsevier Saunders, 11<sup>th</sup> Edition, 2006; 900.
8. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp-12, verse no.11)*. Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 80.
9. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol.II (Chikitsa Sthana, chp-15, verse no.7)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 512.
10. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol.II (Chikitsa Sthana, chp-28, verse no.8)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 616.
11. Priya Vrat Sharma. *Sushruta Samhita(2) (Nidana Sthana, chp-1, verse no.18)* Varanasi; Chaukhamba Visvabharati; Reprint edition, 2010; 6.
12. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp- 21, verse no.5, 6)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 116.
13. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp- 22, verse no.3, 4)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 120.
14. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp-14, verse no.64)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 92.
15. Patrick Schrauwen, Wouter D van Marken, Lichten belt. Combating type 2 diabetes by turning up the heat. *Diabetologia*, Nov. 2016; 59(11): 2269-2279.
16. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp- 14, verse no.16)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 88.
17. Rebeca P. Dearlove, Phillip Greenspan, Diane K. Hartle, Ruthann B. Swanson, James L. Hargrove; Inhibition of Protein Glycation by extracts of culinary herbs and spices. *Journal of Medicinal food*, Vol.11: issue 2: p. 275-281. <http://doi.org/10.1089/jmf2007.536>.
18. J. C. Clapham and J. R. S. Arch. Themogenic and metabolic antiobesity drugs: rationale and oppurtunities. *Diabetes, Obesity and Metabolism*, 2007; 9.3: 259-275. doi: 10.1111/j.1463-1326.2006.00608.x.
19. Westerterp-Plantenga M, Diepvens K, Joosen AM, Berube-Parent S, Tremblay A. Metabolic effects of spices, teas, and caffeine. *Physiol Behav*, 2006 Aug 30; 89-91. Epub 2006 March 30.

20. Paul T Williams, Paul D Thompson. Walking versus running for hypertension, cholesterol and diabetes mellitus risk reduction. *Arteriosclerosis, Thrombosis and vascular Biology*, 2013; 33: 1085-1091 published April 10, 2013.
21. Havard Nygaard, Sissel Erland Tomte and Arne Torbjorn Hastmark. Slow postmeal walking reduces postprandial glycemia in middle aged women. *Applied physiology, Nutrition and Metabolism*, 1 Dec. 2001; 34,(6): 1087-1092. doi.org / 10.1139 /H 09-110.
22. Prof. Srikantha Murthy. *Ashtanga Samgraha(2) (Chikitsa Sthana, chp-14, verse no.20) Varanasi; Choukhambha Orientalia; 5<sup>th</sup> edition, 2005; 435.*
23. Mansoo ko, Lynne Hughes, Harriet Lewis. Walking speed and peak plantar distribution during barefoot walking in person with diabetes. *Physiotherapy research international*, March 12; 17(1): 29-35 10.1002/pri509
24. Thomas T Van Sloten, Hans H.C.M. savelberg et al. Peripheral neuropathy, decreased muscle strength and obesity are strongly associated with walking in persons with type 2 diabetes without manifest mobility limitation. *Diabetes research and clinical practice*, 91(1): Jan 11, pages 32-39.  
doi:-org/10.1016/j.diabetes.2010.09.030
25. Periard J D, Racinais S, Sawka M N. Adaptations and Mechanisms of Human Heat Acclimation: Applications for competitive Athlets and sports. *Scand J Med Sci Sports*, 2015 Jun; 25(1): 20-38. doi.10.1111/sms.12408.
26. Nadal E R, Pandolf K. B., Roberts M. F. Mechanisms of thermal acclimation to exercise and heat. *Journal of Applied Physiology*, Oct 1974; 37: 515-520.
27. Priya Vrat Sharma. *Sushruta Samhita (Chikitsa Sthana, chp- 11, verse no.11) Varanasi; Chaukhamba Visvabharati; Reprint edition, 2010; 128.*
28. Ramiah S A. *Yoga Therapy for Diabetes: Washington, D.C. Study, International conference on Traditional Medicine, 1986, Madras. Madras, India: Published by Siddha Medical Board, Govt. of Tamilnadu.*
29. Priya Vrat Sharma. *Sushruta Samhita, (Chikitsa Sthana, chp-11, verse no.11) Varanasi; Chaukhamba Visvabharati; Reprint edition, 2010; 128.*
30. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp- 22, verse no.24) Varanasi; Chaukhamba Orientalia; Reprint edition, 2001; 1: 121.*
31. Priya Vrat Sharma. *Sushruta Samhita, (Chikitsa Sthana, chp-24, verse no.51) Varanasi; Chaukhamba Visvabharati; Reprint edition, 2010; 228.*

32. Baron A D, Steinberg H, Brechtel G, Johnon A. Skeletal muscle blood flow independently modulates insulin mediated glucose uptake. *Am J Physiol*, 1994 Feb; 266(2pt): E 248-53.
33. Castro-Sanchez A M et al. Connective tissue reflex massage for type 2 diabetes patients with peripheral arterial disease randomized controlled trial. *Evid based Complement Alternate Med*, 2011; 2011: 80h321.  
doi: 10.1013/ecam/nep171.Epub 2011 March 13.
34. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp- 5, verse no.94)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 43.
35. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Nidan Sthana, chp-4 verse no.50)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 215.
36. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp- 21, verse no.12)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 117.
37. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp-21, verse no.19)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 117.
38. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp-21, verse no.27)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 117.
39. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp- 23, verse no.17-21)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 123.
40. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp-4, verse no.21)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 33.
41. Vaidya Jadavaji Trikamji Aacharya. *Charaka Samhita Vol. I (Sutra Sthana, chp-1, verse no.61)* Varanasi; Chaukhamba Orientalia; Reprint edition, 2011; 17.
42. Nisteswar k, Dhyani S.C, Vasavada S.V. Effect of sheeta and ushna veeraya drugs on basal metabolic rate. *Journal of research of Ayurveda and Siddha*, 990; 2(4): 327-332.
43. Harshita Kumari, Reshmi Pushpan and K. Nishteswar. Medohara and lekhaniya dravyas (anti-obesity and hypolipidemic drugs) in Ayurvedic classics: A critical review. *Ayu*, 2013 Jan-Mar; 34(1): 11-16. doi: 10.4103/0974-8520.115437.