EFFECT OF STEAM BATH AND SAUNA BATH ON SERUM TRIGLYCERIDE LEVELS IN OBESE INDIVIDUALS- A COMPARATIVE STUDY

[1]Dr. Vasanth Kumar S R, [2]Dr. Vanitha S Shetty, [3]Dr. Nitesh M K, [4]Dr. Lakshmeesh D R

[1]PG Scholar, [2]Principal and Dean, [3]Assistant Professor and PG Coordinator, [4]Associate Professor
Department of Clinical Naturopathy,
Alva's College of Naturopathy and Yogic Sciences , Moodbidri , Karnataka

ABSTRACT

Background and Objectives

Obesity is a medical condition in which excess or abnormal body fat gets accumulated in adipose tissue that causes adverse effects on health, which leads to reduced life expectancy. Its increasing prevalence worldwide makes obesity an important health issue. Steam bath is one of the most important forms of water treatments, which induces perspiration in a most natural way. Sauna bath, is a form of dry heat therapy practiced for purpose of relaxation and pleasure. Excessive intake of carbohydrate, fat or alcohol may each contribute to increased plasma triglyceride (TG) by different mechanism. Elevated triglyceride is common in obesity, diabetes and insulin resistance. Present study was aimed to evaluate and compare the effect of steam bath and sauna bath on serum triglycerides in obese individual.

Materials and methods: A total of 100 Subjects were screened for inclusion and exclusion criteria and recruited. Randomly divided into 2 groups Group1 (Steam bath) and Group2 (Sauna Bath) Pre-assessments were recorded before the intervention. Intervention was given daily morning for 10days.Group 1(STB): Subjects received steam bath for 15 minutes. Group 2(SB): Subjects received sauna bath for 15 minutes. Post assessments were recorded after 10 days of intervention.

RESULTS: Within group changes suggested significant changes in Triglyceride ($p \leq 0.001$), waist circumference ($p \leq 0.001$), hip circumference ($p \leq 0.001$), and BMI in both the groups on comparison with their respective baseline values. Waist hip ratio showed a greater change following sauna bath ($p \leq 0.001$) as compared to the steam bath ($p=0.032$).

INTERPRETATION AND CONCLUSION: Sauna bath and steam bath are two different treatments in naturopathy application of these hydriatic therapies causes significant reduction in triglyceride levels also reduction in waist circumference and hip circumference were observed. Thus, application of sauna bath and steam bath treatments causes effective decrease in triglyceride levels among obese individuals.

Keywords: Obesity, Sauna Bath, Steam bath, Naturopathy, Hydrotherapy, Triglycerides

INTRODUCTION

Obesity is an amount of excess weight so that connected with adverse health effects. In adults, overweight and obesity are defined using the body mass index (BMI), which is the ratio of weight in kilograms divided by the height in meters squared. Overweight is defined as a BMI between 25.0 and 29.9 kg/m2, and obesity is defined as a BMI higher than 30.0 kg/m^2.[1] World Health Organisation (WHO) defines obesity as an excess in fat mass great enough to increase the risk of morbidity, altered physical, psychological, or social well- being and/ or mortality.[2]

Overweight was defined as a BMI ≥23 kg/m2 but <25 kg/m2 for both genders (based on the World Health Organization Asia Pacific Guidelines) with or without abdominal obesity (Abdominal obesity).[3] WHO reports indicate that 48% of women and 41% of men in high-income countries do not get enough physical activity, and that physical inactivity causes almost 3.2 million deaths each year.[4] Although obesity is clearly associated with an increased risk for diabetes, coronary heart disease (CHD), degenerative joint disease, and a number of cancers, there has been controversy over the relationship between BMI and mortality.[5]

Naturopathy is a holistic approach to healing that incorporates a range of treatments and natural therapies, based on the belief that the body is capable of healing itself, if given the right support. Unlike conventional medicine, where the focus is on treating the symptoms of disease, naturopathy emphasizes the overall health of a patient.[6]

A steam bath is a method of hydrotherapy treatment modality, where the patient is exposed to moist heat, but not the head.[7] The physiological changes experienced when taking a steam bath are very similar to those experienced when exercising or when suffering from a fever.[8]

Sauna bath is a unique form of heat exposure that involves short-term exposure to exceptionally high temperatures. Thousands of years ago, it was practiced in both cold and warm climates. Sauna bathing continues to be popular in many circumpolar countries, in addition to becoming a widely practiced wellness form in many central European countries during the past few decades. Saunas are log-paneled rooms where bathers sit on benches well above the floor level and enjoy the heat from the heater made of, or filled with, rocks.[9]

Serum triglyceride is also known as neutral fat, excessive intake of carbohydrate, fat or alcohol may each contribute to increased plasma triglyceride (TG) by different mechanism. Elevated triglyceride is common in obesity, diabetes and insulin resistance.[10]

II. Materials and Methods

1. **Study Design:** A randomized controlled trial. All the subjects received intervention for the duration of 15mins, twice daily for 10 days.
2. **Subjects**
   A total population of 120 subjects were screened out of that Sixty subjects based on inclusion and exclusion criteria, with the age ranging from 18 to 40 years were recruited in the study. The study population was selected from the students and OPD and IPD of Alva's College of Naturopathy and Yogic Sciences and Hospital, Moodbidri, Mangalore. DK.574227.

Ethical Considerations

Subjects who fulfilled the inclusion criteria were shown information sheet having details regarding the nature of study and intervention to be used. Subjects were given enough time to go through the study details mentioned in the information sheet. They were given the opportunity to ask any questions and if they agree to participate in the study, they were asked to sign the informed consent form which was mainly provided in English language.

CTRI Registration Number:

Criteria for diagnosis

The diagnosis was made based on the redefined BMI criteria of the World Health Organization (WHO). Study involved obese individuals with BMI above 25 kg/m2. Based on the revised consensus guidelines for India the classification of obesity based on BMI is shown in table 2

Table 1: Classification of obesity based on BMI[11,12]

CATEGORY	BMI (kg/m2)
Underweight	≤ 18.5
Normal range	18.5 – 22.9
Overweight	≥ 23.0
At risk	23.0 – 24.9
Obese class-1	25.0 – 29.9
Obese class-2	≥ 30.0

Inclusion criteria

- Age – 18 to 40 years(180)
- Subjects who are diagnosed as obese according to WHO classification of BMI.
- Gender – Female and Male
- Subjects willing to participate in the study by signing the consent form.

Exclusion Criteria:

- Subjects with open wounds
- Subjects who underwent recent surgeries
- Subjects with co-morbid conditions like hypothyroidism
- Subjects with organomegaly
- Females undergoing menstruation.[13]
- Subjects with history of alcohol and nicotine.[14]

Intervention

STEAM BATH:

- Temperature –110F to 130F with 100% humidity
- Duration -10 to 15 minutes

Procedure –prior to the intervention the subject has to drink sufficient amount of water and take a cold shower before entering steam chamber. Ask the patient to sit in the steam chamber with minimal dress with a cold compress on head. After the intervention the subject should dry himself with a dry towel and dressed up for the post assessment which will be done after 10days intervention.[15]

SAUNA BATH

- **Temperature** - 800C to 1000 C (176F to 212F) with 10-20% humidity.(185)
- **Duration –** 15 minutes

Procedure –Before entering the chamber, the patients should drink plenty of cold water while in the cabin the person should frequently rub himself to encourage dilation of the surface vessels. When he feels sufficiently hot, the patient should take a cold shower and quickly dry himself. Post assessment data which will be done after 10 days intervention.[16]

4.5 ASSESSMENTS

Serum triglycerides: The blood is drawn from a vein in the front of your elbow or the back of your hand, using all antiseptic measurements. Patient may need to fast (no food or drink) for 9 to 12 hours before the blood is drawn. The sample drawn is then collected and sent to a standard NABL accredited laboratory for assessments.

Anthropometric measurements: The body weight will be measured without shoes using an electronic measuring scale, and height to the nearest centimetre will be taken. The BMI will be calculated as weight in kilograms divided by height (in meters squared).

Waist circumference (WC) in centimetres will be measured midway between the lower costal margin and the iliac crest during the end-expiratory phase. Hip circumference (HC) in centimetres will be measured at the level of the greater trochanters. The waist-hip ratio (W/H) will be defined as the waist circumference divided by the hip circumference, and the waist-height ratio (W/Ht) will be defined as the waist circumference divided by the height in centimetres.[17]

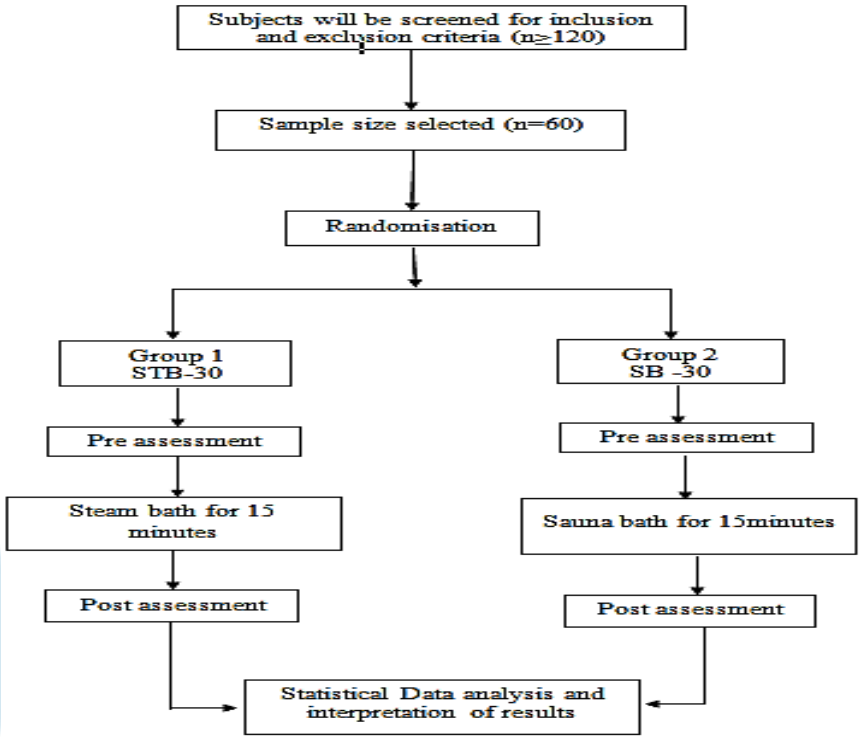

Figure 1. Illustration of the study plan

RESULTS

Analysis of variance showed no significant difference in triglycerides between the steam and sauna bath interventions after adjusting for their respective baseline values F (1,54) =3.04, p=0.087, η^2p=0.053. Turkey's post-hoc test for multiple comparisons found that the mean values of triglycerides of steam and sauna bath were not different (p=0.087, 95% C.I. =1.61, 22.97).

A one-way Analysis of Variance showed that there was a significant difference in waist circumference between steam and sauna bath interventions after adjusting for their respective baseline values F (1,54) =14.36, p<0.001, η^2p=0.21. Turkey's post-hoc test for multiple comparisons found that the mean values of the steam bath and sauna bath were significantly different (p<0.001, 95% C. I=5.24, 17.00).

Analysis of variance showed significant difference in the Hip Circumference levels between the steam and sauna group interventions after adjusting for their respective baseline values F (1.54) = 12.731, p<0.001, η^2p=0.191. Turkey's post-hoc test for multiple comparisons found that the mean values of hip circumference steam and sauna bath (p<0.001, C.I. = 6, 51, 23.19).

Analysis of variance for waist hip ratio between the two groups did not show any significant difference F (1, 54) =0.018, p=0.895, η^2p < 0. 001.Also, no significant differences were observed between the groups for BMI F (1, 54) =1.221, p=0.274, η^2p=0.022.

Within group changes suggested significant changes in Triglyceride (p≤0.001), waist circumference (p≤0.001), hip circumference (p≤0.001), and BMI in both the groups on comparison with their respective baseline values. Waist hip ratio showed a greater change following sauna bath (p≤0.001) as compared to the steam bath (p=0.032).

Statistical Analysis

The present study was designed a two-group pre-post interventional study to assess the effect of steam and sauna baths on lipid profile of individuals with Obesity. Analysis of variance was performed to assess the within and between group differences. All the assumptions were checked and Turkey's tests for post-hoc comparisons were performed.

	Steam Bath (Mean ± SD)		Sauna Bath (Mean ± SD		F value	η^2_p	p-Value
	Pre	Post	Pre	Post			
Age	22.66±3.12		23.48±4.8				
TG_Pre	86.52±22.4	80.71±22.18^{+}	75.14±22.47	69.24±21.98^{+}	3.04	0.053	0.087
WC_Pre	98.48±12.98	93.97±12.22^{+}	87.85±8.32	83.63±8.41^{+}	14.36	0.21	<0.001
HC_Pre	114.45±18.17	111.03±16.33^{+}	100.63±10.36	97.74±9.53^{+}	12.73	0.191	<0.001
WH_Ratio_Pre	0.86±0.07	0.85±0.06$^{\#}$	0.87±0.05	0.85±0.05^{+}	0.018	<0.001	0.895
BMI_Pre	26.5±4.46	25.08±4.47^{+}	25.8±1.49	24.56±1.45^{+}	1.221	0.022	0.274

Table: 4 p≤0.001, p≤0.05 for within group analysis using paired t test
P-value in the table indicated between group comparisons using analysis of variance

	Mean Difference	Lower	Upper	SE	t	Cohen's d	Lower	Upper	pbonf
Steam Sauna	0.346	−1.075	1.768	0.709	0.489	0.1 48	−0.460	0.756	0.627

Table-9: comparison group of post hoc test values in two groups

Discussion

Results of present study show within group there is a significant change in Triglycerides, waist circumference, hip circumference and BMI in both the groups on comparison with their respective baseline values. Waist hip ratio showed a greater change following sauna bath as compared to the steam bath.

The main aim of the current study was to assess and compare the effect of steam bath and sauna bath on serum triglyceride levels among obese individuals. This was a randomized controlled trial with a sample size of 60 subjects who were randomly allocated into two groups. Group 1(Steam bath) n=30 and Group 2 (Sauna bath) n= 30. The assessment criteria was Serum triglyceride levels, and anthropometric measurements, There were no adverse effects reported during or after the intervention.

In the present study, steam bath group has significant reduction in median BMI, average weight, average Waist-Hip ratio, along with mean triglyceride levels. There are significant changes are found in between both Sauna and Steam bath group but a significant difference in waist circumference, Hip Circumference levels were found both the groups.

In support to the results of our study a previous study concluded obesity acts as a prominent risk factor for morbidity, disability, and mortality.[18] The effects of intentional weight loss on health are of obvious importance in determining public health recommendations for weight loss in obese individuals. Numerous studies have shown that, over the short term (weeks or months), intentional weight loss in obese individual reduces risk factors for and improves symptoms of obesity-related conditions, including heart diseases, type 2 diabetes mellitus, and osteoarthritis.[19]

In previous study, it was evident that, steam bath could also induce thermal stress, and as a reaction, the cardiovascular system would increase the HR. Raise in blood temperature, and reflex stimulation of adrenergic cardiac beta-receptors are the possible mechanisms for the increase in HR (heart rate) during thermal stress. It might be the possible reason for observed elevation in the SBP (systolic blood pressure) immediately following steam bath in our study which primarily depends on cardiac output. The elevated SBP (systolic blood pressure) gets reduced below baseline after a recovery period and decreases in SBP with a concomitant increase in HR seen in the steam bath is more likely due to the sympathetic and parasympathetic regulation of heart.[20]

Studies suggest that steam bath has been proven to be an effective non-pharmacological therapy for patients with congestive heart failure due to its ability to reduce preload and afterload on the heart.[21] In a study of 8 healthy men (mean age 30 years, range 22 to 53 years) exposed to a temperature of 80 to 90^0 C for 30 minutes in a sauna, heart rates increased from 78.5 to 103.6 beats per minute.[22] In previous study, sauna baths may also have direct effects on the lung tissue by reducing pulmonary congestion and increasing tidal volume, vital capacity, ventilation, and forced expiratory volume of the lungs.[23] In Previous studies using sauna bath also revealed that a significant improvement in cardiovascular parameters among subjects with hypertension as well as in healthy volunteers.[24] Studies suggest that, Sauna therapy decreases weight in obese people and lowers blood pressure, thus improving vascular endothelial function and left ventricular ejection fraction in patients with cardiovascular disease. It suggests that thermal therapy can prevent atherosclerosis.[25]

The probable mechanism of action indicating the regulation of the speed of metabolic changes in the human body depends mainly on the functioning of the nervous and endocrine system and the activity of the key enzymes in peripheral tissues. In steam baths, the sympathetic and adrenal systems are stimulated, endocrine changes are induced, and the internal body temperature is raised. Hormones affect lipid metabolism primarily by controlling the speed of key enzyme synthesis and modification of the activity of those enzymes. Influence of steam bath showed significant changes in the lipid levels may be due to hyperthermia and hyperactivity of ACTH, cortisone etc.[26]

As a result of increased removal of LDL particles during thermal therapy, LDL particles with a higher affinity for LDL receptors are produced and are catabolized more rapidly. An increase in HDL production and stimulation of reverse cholesterol transport. It increases the production of Apo A-1 and Apo A-2 in liver and contributes to increase in plasma HDL concentration and a more

efficient reverse cholesterol transport. Moderate exercise will raise HDL levels. Steam bath gives the same benefits of moderate exercise without the exertion, and exercise is involved in increasing the production and action of several enzymes that function to enhance the reverse cholesterol transport system.[27,28]

Sauna baths cause an increase in metabolic rate resulting from excitation of the sympathoadrenal system, hormonal changes and increased internal temperature of the body.[29] In the available reference material, the trends of metabolic changes in the specific conditions of the human body overheated in the Finnish sauna are limited. In the human body, metabolic changes are regulated primarily by the functioning of the nervous and endocrine systems and by the activity of key enzymes in peripheral tissues. Hormones affect lipid metabolism mainly by regulating the rate of enzyme synthesis and their activity. After sauna bathing, the concentration of such hormones as ACTH, cortisol, and HGH was found to increase.[30]

Adipose tissue transports free fatty acids to various internal organs for metabolic and structural purposes, and they play an important role in metabolism as one of the primary energy sources. Free fatty acids constitute the main form of fatty acids transportation from adipose tissue to the majority of internal organs for metabolic and structural purposes and they play a major role in metabolism as one of basic energetic substrates. Free fatty acids are a lipid fraction of very short duration — about 2 to 3 minutes — and their level in the blond serum is changeable and depends on many factors, mainly on the metabolic conditions of the organism. The concentration of free fatty acids increases during fasting and physical effort. The factors intensifying lipolysis in adipose tissue cells, increasing thereby the concentration of FFA in blood are glucagon, catecholamines, ACTH, cortisol, growth hormone and the activity of sympathetic nervous system. Glucose and insulin, on the other hand, are factors inhibiting lipolysis and stimulating the process of lipogenesis. The increase in the secretion of lipolytic hormones, such as HGH, ACTH, cortisol and prolactin, which can be responsible for the increase in FFA, had been described before.[31,32] Other factors that activate lipolysis in thermal stress conditions are an increase in catecholamine and glucagon secretion, as well as stimulation of the sympathetic part of the autonomic nervous system.[33,34] As a result of insulin secretion inhibition and insulin resistance to glycaemia, lipogenesis is inhibited, which results in lower peripheral FFA levels. As a result of overheating in saunas, FFA concentration may increase as a result of intensified lipolysis and decreased lipogenesis. Changes in cholesterol fractions following a single or repeated thermal sauna bath.[35]

Hence with the results obtained from our study it can be suggested that both steam bath and sauna bath in the form of dry heat and wet heat that excites sympathoadrenal system, hormonal changes and sympathetic and adrenal systems are stimulated, endocrine changes are induced. The steam bath possibly enhanced the cardiac health more hormonal changes efficiently than sauna bath. These can be attributed to various effects of steam bath and sauna bath such as reflex baroreceptor activation favouring a better autonomic control, release of local vasodilators, hormonal regulation, and chemical effect.

Strengths of the study

1. It was a randomized controlled trail with the clinical application.
2. No adverse effects or serious complications were recorded.
3. This is the first study done to evaluate the effect of steam bath and sauna bath on serum triglyceride levels in obese individual.
4. This is the first study done to assess efficient treatment modality among steam bath and sauna bath.

Limitations

- All the variables including body composition were not studied.
- Smaller sample size might have influenced the result observed.
- Specific diet protocol to follow during the intervention was not given to subjects.

Recommendations for future research

1. Study can include larger sample size.
2. Assessments during the intervention as well as with a longer follow up period.
3. Intervention can be given for more days to achieve better results.
4. This study can be done for a longer duration for the effectiveness of the treatment and better understanding of the underlining mechanism.

CONCLUSION

In our study application of sauna bath and steam bath treatments causes effective decrease in triglyceride levels among obese individuals. Further clinical trials are required to document effectiveness of these treatment modalities.

BIBLIOGRAPHIC REFERENCES

1. Bessesen DH. Update on obesity. J Clin Endocrinol Metab. 2008;93(6):2027–34.
2. Khadilkar V V., Khadilkar A V., Cole TJ, Chiplonkar SA, Pandit D. Overweight and obesity prevalence and body mass index trends in Indian children. Int J Pediatr Obes. 2011;6(2–2):216–24.
3. Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, Dhandania VK, Madhu SV, Rao PV, Geetha L SR. Prevalence of generalized & abdominal obesity in urban & rural India-the ICMR-INDIAB Study (Phase-I)[ICMR-INDIAB-3]. Indian J Med Res. 2015;Aug;142(2)(139).
4. Esteghamati A, Mazaheri T, Rad MV, Noshad S. Complementary and alternative medicine for the treatment of obesity: A critical review. Int J Endocrinol Metab. 2015;13(2).
5. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess Deaths Associated With Underweight, Overweight, and Obesity: An Evaluation of Potential Bias. Vital Heal Stat Ser 3, Anal Epidemiol Stud [Internet]. 2018;0(42):1–21. Available from: http://www.ncbi.nlm.nih.gov/pubmed/30216148
6. Kohli M, Kohli G. Understanding of Naturopathy Understanding of Naturopathy. Int J Nurs Educ Res.

2014;2(2)(July):135–9.
7. Pandiaraja M, Vanitha A, Maheshkumar K, Venugopal V, Poonguzhali S, Radhika L, et al. Effect of the steam bath on resting cardiovascular parameters in healthy volunteers. Adv Integr Med [Internet]. 2020; Available from: https://doi.org/10.1016/j.aimed.2020.06.001
8. Em B, Lund H, Kb H, Dagfinrud H, Christensen R. Aquatic exercise for the treatment of knee and hip osteoarthritis (Review). 2009;(4).
9. Kukkonen-Harjula K, Kauppinen K. Health effects and risks of sauna bathing. Int J Circumpolar Health [Internet]. 2006;65(3):195–205. Available from: https://www.tandfonline.com/action/journalInformation?journalCode=zich20
10. Colledge NR, Walker BR RS. Davidson's Principles & Practice of Medicine.(21.Edition). Churchill Livingstone Elsevier. 2010. 449 p.
11. Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D, et al. Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. J Assoc Physicians India. 2009;57(2):163–70.
12. Ko GT, Chan JC, Cockram CS WJ. Prediction of hypertension, diabetes, dyslipidaemia or albuminuria using simple anthropometric indexes in Hong Kong Chinese. Int J obesity. 1999;Nov;23((11)):1136–42.
13. Princi T, Parco S, Accardo A, Radillo O, De Seta F GS. Parametric evaluation of heart rate variability during the menstrual cycle in young women. Biomed Sci Instrum. 2005;Jan 1(41):340–5.
14. Koskinen P, Virolainen J KM. Acute alcohol intake decreases short-term heart rate variability in healthy subjects. Clin Sci. Aug;87(2):225–30.
15. Jindal Nature Cure Treatments. 8th ed. Ba. 1998. 30 p.
16. Jindal nature cure treatments. 8th ed. Ba. Institute of naturopathy & yogic sciences; 1998.
17. Goh VH, Tain CF, Tong TY, Mok HP WM. Are BMI and other anthropometric measures appropriate as indices for obesity? A study in an Asian population. J Lipid Res. 2004;Oct 1;45(10):1892–8.
18. Kritchevsky SB, Beavers KM, Miller ME, Shea MK, Houston DK, Kitzman DW NB. Intentional weight loss and all-cause mortality: a meta-analysis of randomized clinical trials. PLoS One. 2015;Mar 20;10(3):e0121993.
19. Billington CJ, Epstein LH, Goodwin NJ, Hill JO, Pi-Sunyer FX, Rolls BJ, Stern J, Wadden TA, Weinsier RL, Wilson GT WR. Overweight, Obesity, and Health Risk. Arch Intern Med. 2000;160(7):898–904.
20. Pandiaraja M, Vanitha A, Maheshkumar K, Venugopal V, Poonguzhali S, Radhika L, et al. Effect of the steam bath on resting cardiovascular parameters in healthy volunteers. Adv Integr Med [Internet]. 2020; Available from: https://doi.org/10.1016/j.aimed.2020.06.001
21. Em B, Lund H, Kb H, Dagfinrud H, Christensen R. Aquatic exercise for the treatment of knee and hip osteoarthritis (Review). 2009;(4).
22. Saadat H, Sadeghi R, Motamedi MR, Namazi MH, Safi M, Vakili H, Sadaghiani K SZ. Potential role of thermal therapy as an adjunct treatment in congestive heart failure. J Tehran Univ Hear Cent.
23. Saikhun J, Kitiyanant Y, Vanadurongwan V PK. Effects of sauna on sperm movement characteristics of normal men measured by computer-assisted sperm analysis. Int J Androl. 1998;Dec 1;21(6):358–63.
24. Laitinen LA, Lindqvist A HM. Lungs and ventilation in sauna. Ann Clin Res. 1988;Jan 1;20(4):244–8.
25. Pandiaraja M, Vanitha A, Maheshkumar K, Venugopal V, Poonguzhali S, Radhika L, et al. Effect of the steam bath on resting cardiovascular parameters in healthy volunteers. Adv Integr Med [Internet]. 2020; Available from: https://doi.org/10.1016/j.aimed.2020.06.001
26. Shiralkar DV. Effect of steam sauna bath on weight loss and lipid profile. J Med Sci Clin Res. 2018;6(8):725–30.
27. Kukkonen-Harjula K, Oja P, Laustiola K, Vuori I, Jolkkonen J, Siitonen S VH. Haemodynamic and hormonal responses to heat exposure in a Finnish sauna bath. Eur J Appl Physiol Occup Physiol. 1989;Mar;58(5):543–50.
28. Pilch W, Szyguła Z, Klimek A, Pałka T, Cisoń T, Pilch P, et al. Changes in the lipid profile of blood serumin women taking sauna baths of various duration. Int J Occup Med Environ Health. 2010;23(2):167–74.
29. Biro S, Masuda A, Kihara T TC. Clinical implications of thermal therapy in lifestyle-related diseases. Exp Biol Med. 2003;Nov;228(10):1245–9.
30. Pilch W, Szyguła Z, Klimek A, Pałka T, Cisoń T, Pilch P, et al. Changes in the lipid profile of blood serumin women taking sauna baths of various duration. Int J Occup Med Environ Health. 2010;23(2):167–74.
31. Pilch W, Szygula Z, Zychowska M. THE INFLUENCE OF SAUNA TRAINING ON THE HORMONAL SYSTEM OF YOUNG WOMEN. J Hum Kinet. 2003;9:19–30.
32. Pilch W, Szyguła Z, Klimek A, Pałka T, Cisoń T, Pilch P, et al. Changes in the lipid profile of blood serumin women taking sauna baths of various duration. Int J Occup Med Environ Health. 2010;23(2):167–74.
33. Kukkonen-Harjula K KK. Health effects and risks of sauna bathing. Int J circumpolar Heal. 2006;Jul 18;65(3):195-205.
34. Research A of clinical. Man in the sauna. Kauppinen K, Vuori I. 1986;Jan 1;18(4):173–85.
35. Tatar P, Vigas M, Jurcovicová J, Jezová D, Strec V PM. Impaired glucose utilization in man during acute exposure to environmental heat. Endocrinol Exp. 1985;Dec 1;19(4):277–81.