



Research Article

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EFFECT OF AEROBIC EXERCISE ON ANTHROPOMETRIC AND METABOLIC PARAMETERS IN OBESE TYPE-2 DIABETICS WITH REFERENCE TO SPECIFIC BODY CONSTITUTION (PRAKRITI)

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ABSTRACT

This study was planned to assess the effect of exercise in obese type-2 diabetics on anthropometric and metabolic parameters with respect to prakriti. For the purpose of study, 30 Obese Type Diabetes Mellitus subjects were enrolled (30-55 years of both sex). BMI, Blood sugar level, serum insulin level, HOMA-IR, HOMA-% S and HOMA-% B were done to assess the effect of exercise. Significant decrease in BMI, weight and PPBS was observed in both kapha and pitta prakriti group individuals. Statistically significant change in terms of decrease in FBS, serum insulin level, HOMA-IR and increase in HOMA-%S was seen in kapha prakriti group individuals whereas as per prakriti, no change was seen in HOMA-%B. Aerobic exercise has shown immense impact on anthropometric and metabolic parameters on OTDM patients with relation to specific body constitution (prakriti).

Key Words: Prakriti, OTDM, FBS, PPBS, BMI, HOMA-IR, HOMA-%S, HOMA%B, SBP, DBP

INTRODUCTION

Diabetes mellitus (DM) is a complex metabolic disorder characterized by absolute insulin deficiency or resistance leading to hyperglycemia.¹ According to recent estimates, approximately 285 million people worldwide (6.6%) in the age group of 20–79 years had diabetes in 2010 and by 2030, 438 million people (7.8%) of the adult population is expected to have diabetes. India has top ranking in terms of the number of people with diabetes.² Two major types of diabetes exist in human populations. Type 1 diabetes which is 5-10% of all the diabetic population and usually develops in children or young adults is caused by an autoimmune destruction of the insulin-producing pancreatic beta cells in the islets of langerhans. The other 90 – 95% of diabetics have type 2 diabetes, often called adult onset diabetes. Type 2 DM have an impaired response to insulin and do not produce adequate amount of insulin to remain euglycemic.³ Thus both insulin resistance and beta cell dysfunction are the two main defects that contribute to Type 2 DM.^{4,5} However, this augmented obligation for insulin to maintain normal glucose levels increases the stress placed on the pancreatic beta cells. In genetically susceptible individuals, beta cell dysfunctions/failure eventually occur (i.e. the beta cells are unable to secrete enough insulin to compensate for the insulin resistance) giving rise to postprandial hyperglycemia and impaired fasting blood glucose.⁶

Obesity is a major contributor to the global burden of chronic disease and disability.⁷ Obesity is an accumulation of excess of body fat mass and is defined by a body mass index equal to or greater than 30 kg/m².

Prevalence of obesity has increased considerably over the past decades in all parts of the world and currently affects 15 – 30% of the adult populations in Western countries as well as in developing countries.⁷ This condition increases the risk of developing a variety of adverse consequences to human health ranging from metabolic disturbances including type-2 diabetes mellitus (T2DM) and cardiovascular complications.⁸ Within population, the risk of developing diabetes (T2DM) is related to increasing obesity and also to a central distribution of fat and the rate of weight gain during adult life.^{9,10}

Diet has been considered one of the primary pillars of health in Ayurveda. Food is an imperative internal factor that accounts for health as well as for disease. As Hippocrates said 2000 years ago, “Let food be your medicine and medicine be your food.”¹¹ Exercise has been defined as a potential disruption to homeostasis by muscle activity that is either exclusively or in combination, concentric, eccentric or isometric.¹²

Ayurveda has considered dietary and lifestyle management to be the first line of treatment for Prameha. Walking (Parikraman) is very vital and most expedient exercise amongst diabetics. Sushruta has mentioned that physical activity (Parikraman) in forms of various types of exercise like wrestling, sports, riding elephant, horse and chariot, travelling on foot and moving around and also feats of archery should be performed by madhumehi individuals.¹³ Exercise brings lightness to the body, reduces fat and improves the ability to work. It has been recommended that workout should be stopped when slight sweating develops on the forehead.¹⁴

The role of human constitution in the regulation of various physiological mechanism has recently gained attention. The various aspect of human constitution mainly includes its morphological, physiological, psychological and immunological basis. Constitution is the aggregate of the structural, functional and behavioral characters of an individual which are in part determined by genes and impart by environment.¹⁵ Constitution is genetically inherited and responsible for the formation of arbitrary boundary of normalcy. Obviously constitutions embrace both inheritance and body types. Inheritance is a total genetic endowment in the interaction with environment.¹⁶

MATERIALS AND METHOD

30 obese type 2 diabetics (OT2DM) between 30-55 years of both sex having history of less than 2 years were included in this study. Diagnosis of diabetes was made as per American Diabetic Association (ADA) guidelines 2011. 30 obese type-2 diabetics were advised to perform aerobic exercise along with diet restriction of 1800Kcal/day for 90 days. All the subjects were clinically examined and their ECG recordings were done for the exclusion of cardiovascular complications. The study was approved by ethical committee of Institute of Medical sciences, Banaras Hindu University, Varanasi with ethical committee clearance no: Dean/2009-10/835. Before enrolment to study, all the subjects were checked for stable body weight. The exclusion criteria were unstable body weight (within 90 days), FBS>250 mg/dl, acute infection, hepatic, renal, cardiac complications, smoking/using any form of tobacco, alcohol consumption, prior history of stroke or chronic liver disease and pregnancy.

Subject selection

328 patients were randomly selected for the study (30-55 years) from Wound Diabetic Clinic, out of which 150 patients did not match as per inclusion criteria whereas 178 patients matched with inclusion criteria and checked for serum glucose level. 95 patients were normoglycemic and 83 patients were having abnormal glucose level. (Fasting blood sugar level>126 mg/dl). 50 patients were diagnosed as T2 DM. and 33 patients had impaired blood glucose level (IGT- 110 to 125 mg/dl). Out of 50 diagnosed T2 DM patients, only 30 patients had given consent for the study.

Criteria for the assessment of blood sugar level and HbA1c%

The T2DM patients were already diagnosed as per ADA 2011 criteria. Type 2 diabetic patients were those with FPG \geq 7.0 mmol/l or \geq 125mg/dl and 2 hour PG levels \geq 11.1 mmol/l or \geq 140 mg/dl and HbA1c% \geq 6.5% and other subjects were screened for oral glucose tolerance test.

Estimation of glucose tolerance and HbA1c%

After an overnight fasting, subjects were given 75 gram of glucose orally dissolved in 250 ml of water. Blood samples were drawn at baseline for assessment of FBS and 2 hours after the administration of glucose to check the PPBS level. Serum glucose level (FBS, PPBS) was estimated by glucose oxidase/ glucose peroxidase method by commercial kit as per manufacturer's instructions

(Randox diagnostics, India) Blood glucose level was estimated in CCIM lab, S. S. Hospital, IMS, BHU. HbA1c% was measured with ion-exchange chromatography method using the DS5 system (Drew Scientific Inc Dallas, Texas). It was estimated in Endocrinology Lab, S. S. Hospital, IMS, BHU, India.

Estimation of lipid profile

The serum level of total cholesterol [cholesterol oxidase/peroxidase (CHOD-POD) method], high density lipoprotein cholesterol [direct clearance method], low-density lipoprotein cholesterol [direct clearance method], triglycerides [end point calorimetry enzymatic test] were quantified with Randox diagnostic kit using Prietest touch robotic bio-chemistry semi auto analyzer at 600nm.

Sample collection

For the biochemical and other tests, 5 ml of blood samples were collected from the subjects. Blood samples were drawn after a minimum fasting period of 12 hours. Serum was separated from the blood and preserved in - 80^o C deep fridge till the estimation.

Estimation of serum insulin

The level of serum Insulin (Labor Diagnostika, Nordhorn), was measured by sandwich enzyme-linked immuno-sorbent assay (ELISA) kit as per manufacturer's protocol. In brief, a monoclonal antibody specific for insulin was coated already onto a microplate. Subsequently, standards and samples were added into the wells and any insulin present was bound by the immobilized antibody. After washing away any unbound substances, an enzyme-linked monoclonal antibody specific for insulin was added to the wells. Following a wash to remove any unbound antibody-enzyme reagent, 3,3',5,5'-Tetramethylbenzidine (TMB) substrate solution was then added to the wells and a blue color was developed in proportion to the amount of insulin bound in the initial step. The color development was stopped by adding stop solution and the intensity of the color was measured at 450 nm by Microplate Reader, model 680 S/N 18551.

Assessment of insulin resistance

The assessment of insulin resistance (IR), insulin sensitivity (HOMA-%S) and beta cell function (HOMA-%B) was done by HOMA Model using the computer program HOMA Calculator v2.2.2 (University of Oxford) from pairs of fasting serum glucose and insulin levels.

Exercise protocol

Moderate aerobic exercises (Brisk walking for 300 minutes/week along with 10 sets of upper body and lower body exercise per day along with diet restriction for 1800 Kcal/day during these days were recommended to obese type-2 diabetics. This program was performed under supervision.

Assessment of prakriti

Assesment of deha prakriti was done by using proforma prepared by Verma, V, 2009 for assessment of Deha prakriti based on characters mentioned in different Ayurvedic text books.¹⁷⁻¹⁹ The deha prakriti was designated in terms of dosha predominant dwandaja prakriti, applying the Tar-Tam principle of Ayurveda²⁰ as it is very rare to find the persons with purely single quality predominant deha prakriti. The degree of predominance may vary as per vridha and vridhatar

description in Ayurveda on the basis of percentage score. Individuals having percentage score more than 60% of either of three doshas. For example, the individuals having kaphaja qualities $\geq 60\%$ was enumerated as kapha pradhan individuals. In this study, Vata predominant prakriti was excluded as their fasting blood sugar level (FBS) was more than 250 mg/dl which was in our exclusion criteria.

Statistical Analysis

Statistical analysis was done by using SPSS 16.0 (statistical package for social sciences). All values are given as mean \pm standard deviation. Comparative analysis between two groups was done using paired T –test between the groups.

Table 1: Weight, BMI and Blood pressure of Obese Type-2 diabetics initially and after 90 days of exercise as per Prakriti

Parameters	Prakriti	Mean \pm SD		Paired t-Test t-value
		DME at 0 day	DME (Follow –up) at 90 th day	
Weight (Kg)	Kapha	83.04 \pm 4.8	78.1 \pm 4.7	t= 15.2 p<0.001 (HS)
	Pitta	83.5 \pm 5.6	78.3 \pm 4.7	t=5.3 p<0.001 (HS)
BMI(Kg/m2)	Kapha	31.04 \pm 2.3	29.2 \pm 2.2	t=14.3 p<0.001 (HS)
	Pitta	29.6 \pm 3.3	27.7 \pm 3.2	t=5.2 p<0.001 (HS)
SBP(mm of Hg)	Kapha	131.6 \pm 10.1	132.6 \pm 8.0	t=1.45 p<0.156 (NS)
	Pitta	126.2 \pm 6.5	132.8 \pm 8.4	t=-1.8 p<0.097 (NS)
DBP(mm of Hg)	Kapha	83.3 \pm 4.8	78.8 \pm 4.6	t=-3.37 p<0.003 (HS)
	Pitta	83.1 \pm 5.3	81.7 \pm 4.6	t=0.50 p<0.626 (NS)

Table 2: Blood sugar level and HbA1C% of Obese Type- 2 Diabetics initially and after 90 days of exercise as per Prakriti

Parameters	Prakriti	DME at 0 day	DME at 90 th day	Within prakriti comparison, paired T test, t-value
FBS (mg/dl)	Kapha	130.4 \pm 15.3	120.5 \pm 7.8	t= 2.5 p=0.018 (S)
	Pitta	129.5 \pm 11.3	123.3 \pm 5.5	t=1.3 p=0.22 (NS)
PPBS (mg/dl)	Kapha	189.2 \pm 23.0	144.7 \pm 13.5	t=7.0 p<0.001 (HS)
	Pitta	198.6 \pm 18.0	151.7 \pm 13.1	t=4.9 p<0.001 (HS)
HbA1C%	Kapha	6.1 \pm 0.5	5.8 \pm 0.3	t=2.5 p=0.01 (S)
	Pitta	6.1 \pm 0.3	5.9 \pm 0.1	t=1.4 p=0.198 (NS)

Table 3: Insulin level, HOMA-IR<HOMA-%S, HOMA-%B of Obese Type-2 Diabetics initially and after 90 days of exercise as per prakriti

Parameters	Prakriti	Mean \pm SD		Paired t-Test
		DME 0 day	DME at 90 th day	
Insulin (μ U/ml)	Kapha	25.3 \pm 2.6	21.4 \pm 3.1	t= 4.3 p<0.001 (HS)
	Pitta	25.9 \pm 2.7	21.8 \pm 3.1	t=2.5 p=0.03 (S)
HOMA-IR	Kapha	3.4 \pm 0.4	2.9 \pm 0.4	t=4.0 p<0.001 (HS)
	Pitta	3.5 \pm 0.4	2.9 \pm 0.5	t=2.7 p=0.027 (S)
HOMA%S	Kapha	29.2 \pm 3.0	35.2 \pm 5.2	t=4.4 p<0.001 (HS)
	Pitta	28.5 \pm 3.4	34.2 \pm 5.3	t= 2.4 p=0.039 (S)
HOMA%B	Kapha	111.1 \pm 26.6	109.0 \pm 19.0	t= 0.01 p=0.99 (NS)
	Pitta	112.3 \pm 19.7	107.0 \pm 14.1	t= 0.54 p=0.599 (NS)

RESULTS

The change in terms of decrease in weight and BMI of obese Type 2 DM subjects was observed highly significant in both kapha and pitta prakriti group. Similarly, significant change was observed in DBP in kapha prakriti individuals whereas no change was seen in Systolic BP and Diastolic BP of pitta prakriti individuals.(Table 1) Decrease in FBS and HbA1C% was found significant in kaphaja group whereas change in decrease in PPBS was seen in both kapha and pittaja group.(Table 2) Statistically, significant change was found in serum insulin level in kapha prakriti group whereas improvement in insulin sensitivity was seen in kaphaja individuals while no statistical significance was noticed in beta cell reserve mass volume in any group (Table 3).

DISCUSSION

Prakriti is the psycho physiological constitution of an individual and is resolute at the time of birth by the individual’s dosha predominance. Each individual has a unique ratio of vata, pitta, and kapha dosha, the homeostasis of this ratio is important for the maintenance of the health as well as for the cure of the disease. Due to

imbalance in these dosha owing to indecent diet and lifestyle, disease may occur.¹⁵ The remarkable relationship between prameha and sthaulya (obesity) has been discussed explicitly in Ayurvedic literature, while commenting on Ayurveda Tattva Sandipika, commentator has explained prameha as one of the complications of obesity. Due to physical inactivity and excessive intake of sweet substances, leads to ama (toxic substances) formation, which may produce excess amount of meda dhatu. This refers to an increase in adipose tissue in the body, resulting in obesity. It reflects the current understanding of the peculiar metabolic state in obese individuals, where excess of carbohydrate is largely converted into fatty acids. The multi-factorial contribution of meda (fat), kapha, vata, and agni (digestive power) is a common pathophysiological occurrence of both prameha and obesity.²¹

Hyperinsulinemia and insulin resistance are insidious features of obesity, having direct correlation with body mass index (BMI).²² Charaka has decisively recognized the relationship between obesity and prameha.²³ The role of meda is not only as dushya(disturbed functioning of the dhatu), but meda (fat/adipose tissue) is of great importance in the pathogenesis of prameha and sthaulya.

According to Acharya Charaka, bahudrava shleshma (Kapha that contains too much liquid) joins and affects meda, causing it to become abaddha (unobstructed or fluid) in nature. This form of meda has been described as acting on mamsa (muscle tissue), thereby increasing the volume of body fluid. This has been described as sharirakleda (body fluid) in Charaka Samhita. Thus, excess water in the blood causes increased diuresis. This route of pathogenesis for Prameha is closely related to obesity.²⁴

It has conducted a preliminary study to correlate the underlying pathology of different stages of diabetes mellitus with the different doshic types of prameha.²⁵ In a research correlating diabetes mellitus with doshic types of prameha in which the patients with features of kaphaja prameha were identified as having mild hyperglycemia (i.e., fasting blood sugar [FBS] up to 140 mg/dl), patients having features of pittaja prameha had moderate hyperglycemia (FBS of 140–250 mg/dl) with high catecholamine and cortisol levels.²⁵ These patients were found to be stressed more easily. Patients with features of vataja prameha were identified as having severe hyperglycemia. (FBS>250 mg/dl). In our study also, the response of exercise in kaphaja individuals is better than pittaja individuals.

Similarly in our study, after exercise intervention, decrease in FBS, PPBS and HbA1C% was seen in both prakriti individuals but statistically significant response was better in kapha predominant prakriti individuals than pitta predominant prakriti because the kapha dosha has unctuousness, binding property, strength of the body for bearance, courage and un-greediness qualities, so these individuals follow the instructions thoroughly as well as they adhere to any activity very sincerely, so these individuals have given better response than pitta pradhan prakriti individuals.²⁶ In one study, it was concluded that pittaja individuals have high level of catecholamine and cortisol, so they get stressed out easily, therefore they do not follow the instructions properly.²⁷ While in our study, vata pradhan prakriti individuals were not included as their FBS level was >250 mg/dl which was in our exclusion criteria. The change in weight and BMI was significant in both prakriti individuals. While the change in Systolic BP was not found significant in both prakriti individuals. The change in Diastolic BP was more in kaphaja prakriti than pittaja prakriti individuals.

Type 2 DM occurs due to genetic as well as acquired factors that adversely affect beta cell function and tissue insulin sensitivity.²⁸ For many years it has been controversial whether impaired beta cell function or tissue insulin resistance is the underlying pathogenic element. Until quite recently, it was generally thought that insulin resistance preceded beta cell dysfunction was the primary genetic factor while beta cell dysfunction occurs as a late phenomenon due to exhaustion after years of physiological adaptation of insulin hypersecretion.^{29,30} In our study, decrease in total insulin level and HOMA-IR was more in kaphaja individuals than pittaja individuals. Also the increase in HOMA-%S was more in kaphaja individuals than pittaja individuals whereas no change was seen in HOMA-%B as per prakriti.

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