VOLUME - 14, ISSUE - 11, NOVEMBER - 2025 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Physiology

STUDY OF EFFECT OF YOGA ON GLYCEMIC CONTROL IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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ABSTRACT Yoga is an ancient art, a practical science designed to bring balance and health to the physical, mental, emotional and spiritual dimensions of the individual. Yoga has emerged as a promising therapeutic option for the prevention and management of type 2 diabetes mellitus and its associated comorbidities. There are many postulated mechanisms of how yoga can influence diabetes. This is a cross-sectional study done on 55 type 2 diabetes mellitus patients performing yoga for a period of 12 weeks. Patient's glycemic status was evaluated both at baseline and following 12 weeks of yoga practice. It was found that, 12 weeks of yoga practice in type 2 diabetic subjects has helped to significantly($p<0.001$) reduce the HbA1c levels. Hence, incorporation of yoga as a complementary therapy into the lifestyle of diabetic patients can contribute to improvement in glycemic control.

KEYWORDS : Yoga, Type 2 diabetes mellitus, glycemic control.

INTRODUCTION

Diabetes Mellitus is a major lifestyle disorder which imposes a huge burden on the health care delivery systems[1]. Diabetes Mellitus will become the seventh leading cause of death globally by 2030[2]. According to IDF, diabetes population is on rise to reach 438 million by 2030 of which majority are type 2 diabetes mellitus[3,4]. India is considered to be one of the epicenters of the global diabetes mellitus pandemic[5] and is called the "diabetes capital of the world"[6].

Yoga is an ancient art, a practical science designed to bring balance and health to the physical, mental, emotional and spiritual dimensions of the individual[7,8]. It is a rich heritage of our culture[9]. Yoga helps to bring a perfect balance between body requirements and energy production. It also balances the hormone production and organ functioning, thus helping in healing of several diseases[7,10].

In the recent years, yoga has emerged to be a promising therapeutic option for the prevention and management of type 2 diabetes mellitus and its associated comorbidities[2]. There are many postulated mechanisms of how yoga can influence diabetes. The physical activity component in yoga, which is the 'Asana' involves muscular activity to reduce the blood sugar levels[2].

OBJECTIVE

To evaluate the effect of yoga on glycemic control by measuring HbA1c before and after 12 weeks of yoga in patients with type 2 diabetes mellitus.

METHODOLOGY

This is an interventional study conducted for a time period of 1.5 years. The study was started after obtaining ethical clearance from Institutional Ethical Committee. This study includes 55 newly registered uncomplicated Type 2 diabetes patients at Shankara Yoga Centre, Bangalore. Patients of either sex, aged 35-55 years, willing to undergo 12 weeks of yoga practice, taking oral hypoglycemic drugs and less than 5 years duration of diabetes were included in the study. Patients already practicing yoga for past 6 months, patients on insulin, hypertensives, obese individuals ($BMI>25kg/m^2$), smokers and alcoholics were excluded from the study.

The sample size was calculated based on a previous study done by Savitha Singh et.al[11]. HbA1c in diabetes patients after intervention was 6.4 ± 1.8.

The yoga sessions were conducted under the supervision of a certified yoga trainer at Shankara Yoga Centre, Bangalore. The study subjects were instructed to attend the yoga session in the morning for about 60 minutes each day, 6 days a week, for a period of 12 weeks. Each yoga session consists of 10 min of warm-up exercise, 30 min of Surya namaskar and Asana (yogic postures), 10 min of Pranayama (breath-holding exercise), and 10 min of Dhyana (meditation)[12]. Yoga asanas include tadasana (mountain pose), trikonasana (triangle pose), paschimottanasana (seated forward bend), ardhamatsyendrasana (seated spinal twist), naukasana (boat pose), bhujangasana (cobra pose), dhanurasana (bow pose), vajrasana (supine thunderbolt pose), shavasana (corpse pose).

Subjects were asked to restrain themselves from physical activities like walking, cycling or other aerobic exercises which could affect the study parameters. Frequent counselling sessions were conducted to ensure adherence to the yoga practice. A written instruction manual for yogic practices and a general diet plan was provided individually to the study participants.

RECORDING BASELINE CHARACTERISTICS:

During the start of each session of yoga, the baseline characteristics of the study subjects were noted. This includes age and sex of the subjects. Duration of diabetes is also noted down. The height of the subjects in meters (m) were measured using a standard meter rule fitted on to the wall. The body weight in kilograms (kg) was measured in upright posture using a portable digital weighing scale that had been validated with calibrated weighing masses. Body mass index was calculated using the formula:

$BMI = Weight\ in\ kg/(height)^2\ in\ m^2$

Blood pressure was measured over the right arm using mercury sphygmomanometer after 10 min of rest, in sitting posture and is expressed as systolic/diastolic blood pressure in millimeters of mercury (mm Hg).

SAMPLE COLLECTION:

Blood sample were collected twice from all the subjects. First set of blood samples was collected before the starting of yoga session. Second set of blood sample was collected after completion of 12 weeks of yoga session. The subjects were asked to come to the yoga center itself for blood sample collection. Under all aseptic precautions, venipuncture was done and 2 ml of fasting venous blood was collected into an EDTA containing vacutainer for glycated hemoglobin

estimation and was sent to Infosys lab, Victoria Hospital, Bangalore. Enzymatic method is used for HbA1c estimation. The instrument used was ARCHITECT Ci4100 by Abbott.

Statistical Analysis:

Data has been analyzed by descriptive statistics. Results on continuous measurements are presented as Mean ± SD and that of categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance.

Paired t test has been used to find significant difference between the 2 sets of data (before and after intervention). Statistical Package for Social Science (SPSS) of Windows version 17 was used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables etc.[13,14,15].

Significant Figures:

+Suggestive significance (p value: $0.05 < p < 0.10$)
*Moderately significant (p value: $0.01 < p \leq 0.05$)
**Strongly significant (p value: $p < 0.01$)

RESULT

The mean age of study participants was 48.8 years in the study. The average duration of diabetes in the participants was 3.1years.

Table 1: Age And Sex Distribution Of The Sample

Parameters	Frequency (%)	
Age (yrs)	36-40	8 (14.5)
	41-45	6 (10.9)
	46-50	19 (34.5)
	51-55	22 (40)
Gender	Males	31 (56.4)
	Females	24 (43.6)

Table 1 shows age and gender distribution. There were 31 (56.4%) males and 24 (43.6%) females, with a M: F 1.3:1 ratio. The mean age (SD) of the studied population was 48.8±5.4years. The age range was from 36 years to 55 years. 8 (14.5%) were aged between 36 to 40 years. There were 6 (10.9%) in the 41-45 years' age group, 19 (34.5%) in the age group 46-50 years, and 22 (40%) in 51-55 years age group.

Table 2: BMI Distribution Of The Study Participants

Parameters	Frequency (%)	
BMI (kg/m^2)	18-22.9 (Normal)	6 (10.9)
	23-24.9 (overweight)	49 (89.1)

Table 2 represents the BMI of the sample. BMI was calculated from formula, BMI=weight in Kg/ Height in m^2. Majority of our study participants had BMI in overweight range (89.1%).

Table 3: Glycemic Control Of Participants With T2DM At Baseline And Following The 12 Weeks Yoga Intervention

Parameter	Pre-intervention	Post- intervention	p value
HbA1c	8.67(1.64)	7.86(1.47)	<0.001**

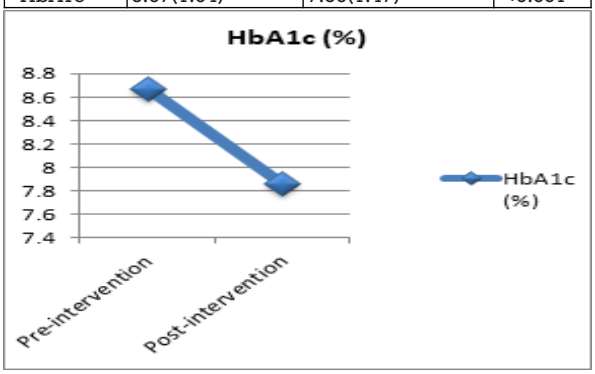

Figure 1: Line graph showing mean HbA1c values pre-intervention and post-intervention

Table 3 and figure 1 shows the mean HbA1c among study subjects before intervention and after intervention. There was a decrease in the mean HbA1c from 8.67±1.64% to 7.86 ±1.47%, which was significant at a p value of <0.001.

DISCUSSION

T2DM is a chronic progressive metabolic disorder characterized by insulin resistance along with relatively reduced insulin secretion[7,2,17,18]. The worldwide prevalence of diabetes is around 2-3%, but is higher in middle and Far East (12% in Indian subcontinents). About 80% of individuals with diabetes live in low income or medium income countries[8,19]. India, Pakistan and Bangladesh comes in the top 10 countries in the world with high estimated number of diabetic patients[20].

The different etiology behind type 2 diabetes includes environmental factors, autoimmunity, genetic factors, insulin resistance, obesity, high body mass index, malnutrition in utero, physical inactivity and newer hormones[21]. In type 2 diabetes, there appears to be a counterproductive interplay between beta-cell inadequacy and insulin resistance, which leads to a vicious circle that perpetuates and aggravates the metabolic disorder[22]. As insulin resistance and compensatory hyperinsulinemia progresses, the pancreatic islets in certain individuals are unable to sustain the hyper insulinemic state. IGT characterized by elevations in postprandial glucose, then develops. A future decline in insulin secretion and an increase in hepatic glucose production leads to overt diabetes with fasting hyperglycemia and at last leading to beta cell failure[23]. Yoga being an age-old practice, emphasis on bringing a general well-being by integrating and incorporating three major components – physical posture, breathing exercises and meditation[8]. Direct rejuvenation/ regeneration of cells of pancreas take place, which increases the utilization and metabolism of glucose in the peripheral tissues, liver and adipose tissue. This rejuvenation is through alternate abdominal contractions and relaxations during asana and breathing exercises. Also, meditation can modulate limbic system activity, through the hypothalamic sympathetic nervous activity and thus regulating endocrine systems[2,7].

The current study helps in evaluation of the effect of yoga on improving the glycemic control in type 2 diabetic patients. The symptoms and long-term complications of diabetes are influenced by the average blood glucose levels. Among the various markers of glycemic control, Glycosylated haemoglobin was considered to be more reliable and used in the present study for evaluating the average glucose levels in the diabetic subjects. Maintaining HbA1c of 7% or lower are shown to reduce the risk of developing chronic complications associated with diabetes[24].

Table 1 shows the age and sex distribution of the study population. There were 31 (56.4%) males and 24 (43.6%) females. The mean age (SD) of the studied population was 48.8±5.4years. Table 2 represents the BMI of the sample showing majority of the study population falling in the overweight category.

Table 3 and figure 1 shows the mean HbA1c value among study subjects before intervention and after intervention. When we look into the mean HbA1c values, there was a decrease from 8.67±1.64% to 7.86 ±1.47%, which was significant at a p value of <0.001.

The present study is consistent with many studies showing a promising result in glycemic control among T2DM patient's adherent to yoga[25,26,27]. Malhotra et al, studied the effect of yoga asana and pranayama in non-insulin dependent diabetes mellitus and has found a significant decrease in glycosylated haemoglobin levels, suggesting the beneficial effect of yoga asanas on diabetes[28]. Also, a community-based follow up

study done by Angadi et al found that adherence to yoga practice has a beneficial effect on the blood glucose parameters in diabetics[21]. Balaji et al found out a significant decrease in HbA1c, suggesting yoga pranayama itself having an impact on the metabolic parameters in uncomplicated type 2 diabetes[29].

Adherence to yoga was assessed in the present study based on participant's daily attendance to yoga class. A duration of 12 weeks (3 months) of yoga was considered based on different existing literatures that has proved a significant reduction in HbA1c with supervised sessions of yoga training lasting for 45-90 min, 3 to 6 days a week or daily for at least 45 days and up to 12 weeks[29,30,31,32,33,34].

The practice of yoga regulates body physiology through control of postures, breathing and meditation[7,28]. Not many studies have explained individually the importance of each asana and pranayama on control of diabetes. BK Sahay studied the effect of different asanas on diabetes and found that practicing Dhanurasana, Ardhamatsayendrasana, Vajrasana, Halasana, Bhujangasana and Naukasana can help in achieving an optimal control on diabetes[9]. According to a study done by Madhavi et al, Dhanurasana was proved to be most effective[35]. In the present study, we used a combination of these asanas along with suryanamaskara, pranayama and meditation for controlling diabetes.

Yogic practice helps in controlling diabetes by its exercise effect, changing biochemical and hormonal profiles, and stress reduction[9]. The exercise effect of yoga is through the asanas which are considered to be slow, static type of muscular exercises[37] with low physical impact[36]. This low-level exercise intensity can generate sufficient muscular contractions to promote increased glucose uptake and clearance. The various twists, stretches and strains in the body increases the blood supply, oxygen delivery and efficiency of internal organs[7]. Abdominal stretching during many yoga postures helps to rejuvenate the cells of pancreas, thus increasing the utilization and metabolism of glucose in peripheral tissues, liver and adipose tissues[29,38,39].

Suryanamaskara is said to provide all benefits of exercise if practiced 3-6 rounds. It helps to increase the blood supply to various parts of body, thus improving the insulin administration[7]. Pranayama is a breathing exercise which improves the oxidative power and blood flow[36]. Also, during meditation practice, concentration on specific organs, especially pancreas can have a positive effect on reducing sugar levels in diabetic patients[7].

Overall, yoga is a relatively low-cost scalable intervention widely available in the community and is simple to learn[15,40]. And unlike the other exercise methods which can make the patient fatigable, yoga can be practiced very easily by the elderly people without any prior experience and also the various postures can be modified according to the individual's physical limitations, yet with beneficial outcomes[2].

CONCLUSION

This cross-sectional study was undertaken to study the effect of yoga on glycemic control in 55 type 2 diabetic patients. The study proves that 12 weeks of yoga practice in type 2 diabetic subjects have significantly reduced the HbA1c value. The central goal of diabetes management includes reduction of blood glucose levels, which can be achieved by the yoga practice. It gives hope for the patients to have a complication free life with relatively less medications.

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