

Quasi Prospective Comparative Study on Effect of Yoga among Prediabetics on Progression of Cardiovascular Risk Factors

Abstract

Introduction: Prediabetic patients have higher risk for cardiovascular diseases, which further increases the rate of mortality. Reason for the rate of increase may be lack of observation, follow-up programs, and self-awareness about the conditions of disease. Lifestyle interventions such as yoga can prove to be a beneficial nonpharmacologic intervention in preventing progression of prediabetes to type 2 diabetes. This study highlights importance of short-term intervention, i.e., yoga in prediabetic patients and use it as a tool for primary prevention of diabetes. **Methods:** This was an interventional study among adults aged 30–50 years in RUHS college of Medical Sciences and Associated Rukmani Devi Beni Prasad Jaipuria Hospital in Jaipur city. The design of study was quasi prospective comparative study. A total of 102 prediabetic patients of age group 30–50 years were recruited from Jaipuria Hospital. These were divided into two groups: study group (Group A, $n = 51$) were engaged in yoga session and control group (B, $n = 51$) not performed any yoga session. **Results:** Yoga intervention resulted in a significant decline in blood glucose ($P < 0.001$), glycated hemoglobin ($P < 0.01$), lipid profile cholesterol ($P < 0.01$), triglyceride ($P < 0.01$), and low-density lipoprotein ($P < 0.01$), but high-density lipoprotein ($P < 0.02$) and very low-density lipoprotein increase ($P < 0.03$) but not statistically significant relative to the control group. **Conclusion:** Short-term yoga intervention is helpful in the control of glycemic parameters like blood glucose, glycated hemoglobin and lipid profile in prediabetic patients. This preliminary study indicates that a yoga program would be a possible risk reduction option for adults at high risk for type 2 diabetes. In addition, yoga holds promise as an approach to reducing cardiometabolic risk factors and increasing exercise self-efficacy for prediabetics performing yoga.

Keywords: Cardiovascular, prediabetes, yoga

Introduction

Diabetes, the most common endocrine disorder, is projected to show a worldwide increase from 366 million people in the year 2011 to 552 million in the year 2030, of which around 101 million is expected to be contributed by India.^[1] Patients with prediabetes do not only have an increased risk of type 2 diabetes but also of cardiovascular diseases (CVDs), including stroke and recurrent stroke.^[2,3] Moreover, the disease manifestations start in the early stages of diabetes and before it gets established as a full-blown condition in the prestage called prediabetes. Prediabetes represents the initial stage of type 2 diabetic disease development; prediabetes disease progression to overt type 2 diabetes occurs when pancreatic beta cells cannot produce insulin to overcome insulin resistance, resulting in

further hyperglycemia.^[4] According to the American Diabetes Association, the diagnostic criteria for prediabetes are an elevated fasting plasma glucose (FPG) level (100 mg/dL–125 mg/dL), a glycated hemoglobin (HbA1c) value of 5.7%–6.4%, or an elevated plasma glucose level after an oral glucose tolerance test (OGTT) (140–199 mg/dL).^[5]

Up to 70% of the patients with prediabetes may develop type 2 diabetes.^[6] The risk of developing type 2 diabetes is approximately 0.7% per year in normoglycemic individuals, whereas patients with impaired fasting glucose or impaired glucose tolerance have a yearly risk of 5%–10%.^[6] The transition from prediabetes to type 2 diabetes usually takes several years but may also be more rapid.^[6] Unless people with prediabetes change their lifestyle, most will have type 2 diabetes within the next

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10 years, according to the National Institute of Diabetes and Digestive and Kidney Diseases.^[7] Knowler *et al.*^[8] estimated that 37% of individuals with prediabetes would have diabetes in 4 years without intervention. If individuals with prediabetes complete a lifestyle intervention program, their risk of diabetes developing in 4 years decreases to about 20%. The prevention of type 2 diabetes in prediabetic patients is an area of concern. Lifestyle interventions such as yoga can prove to be a beneficial nonpharmacologic intervention in preventing progression of prediabetes to type 2 diabetes. The science of yoga is an ancient one and benefits all components of health. The effects of yoga on the endocrine system, nervous system, and physical health are documented with high frequency in the literature. Yoga as a complex intervention includes components with varying degrees of physical movement, mind–body exercises, and in-depth philosophical teachings.^[9] Yoga techniques include the practice of *prāṇāyāma*, which regulates respiration through variety of exercises, and *āsana*, which includes various physical exercises and postures in a highly coordinated manner integrated with systematic breathing.^[10] These exercises have been found to bring about positive biochemical and hormonal changes by eliminating stress and instilling a sense of discipline.^[11] The yogic therapeutics help in restoring the internal secretions to their normal value by securing the health of all the endocrine organs.^[12] The effect of yogic practices on the management of prediabetes has not been investigated well. The aim of this well-designed short-term study was to assess the effect of integrated approach of yoga therapy on glycemic control and lipid profile in prediabetics.

Methods

A quasi prospective comparative, single-blind study was conducted among prediabetic adults aged 30–50 years in tertiary health care center, Jaipur, Rajasthan, India. Written informed consent was taken from the participants in the local language, and the study was approved by ethics committee of the RUHS College of Medical Sciences. A total of 1000 participants were screened, of which 125 were found to be prediabetic. Survey was conducted from August 2017 to December 2017.

Details about the age, sex, family history, sociodemographic, lifestyle, physical activity, BMI, dietary habits, and medical factors were recorded in the information collection pro forma.

In this present study, stress was measured by Cohen Perceived Stress Scale (PSS). The Cohen PSS is the most commonly used psychological instrument for measuring the degree of stress. It is a measure of the degree to which situations in life are appraised as stressful. PSS showed adequate reliability and predictivity correlated with life event scores, depression, and anxiety. The scale includes psychometric properties of the 10-item, i.e., a number of direct questionnaire about current levels of experienced stress. The items are easy-to-use

questionnaire with established acceptable psychometric properties. Moreover, the questions are of a general nature about thought and feeling in past month and not specific to any subpopulation.^[13]

Prediabetes was defined as per American Diabetes Association criteria.^[5] According to the American Diabetes Association, the diagnostic criteria for prediabetes is an elevated FPG level (100 mg/dL–125 mg/dL), a HbA1c value of 5.7%–6.4%, or an elevated plasma glucose level after an OGTT (140–199 mg/dL).^[5] Other inclusion criteria were no history of CVD in the patient or in first-degree relatives, history of diabetes was taken by all the prediabetic patients, and should not be on drugs which affect blood sugar levels. A total of 102 prediabetics were recruited in the study. These were randomly divided into two groups, namely study group (Group A: $n = 51$), i.e., prediabetic with yoga intervention and control group (Group B: $n = 51$), i.e. prediabetic without yoga intervention. Control group did not perform any yoga intervention during study period. Baseline parameters such as anthropometric, blood pressure, and pulse were recorded and biochemical parameters such as blood glucose and lipid profile were measured using enzymatic colorimetric kits on a biochemistry analyzer. The FPG was estimated by glucose oxidase-peroxidase (GOD), end point method^[13] HbA1c was measured by immunoturbidimetric method. Serum lipid profile-total cholesterol (TC) was calculated by enzymatic CHOD-PAP^[14] and triglyceride (TG) by enzymatic GPO-PAP,^[15] high-density lipoprotein (HDL)-cholesterol by phosphotungstic acid end point method,^[15] and low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) were calculated from the Friedewald's formula.^[16] Evaluation was done before yoga intervention then after 3 months post intervention, and the person who carried out biomedical assessment was naïve to the group identity.

Yoga was used as an interventional therapy in this study. Yoga training was given by certified yoga instructor. These sessions were approximately 45 min 6 days in a week over a period of 3 months. The integrated approach of yoga therapy included Prayer, Omkar recitation, yoga postures (*asanas*), breathing (*pranayama*) techniques, *Shavasana*, and counseling, and diet was also a part of the program. To facilitate and guide home practice, participants were given an video recording (CD) of the yoga sessions recorded under direction of the certified yoga instructor in RUHS College of Medical Sciences, and compliance of patients was checked by message daily and weekly telephonic conversions. The components of intervention using integrated approach of yoga therapy are detailed in Table 1.

The patients were encouraged to perform all exercises as accurately as possible. Each *asana* lasted 30–60 s, and some of them were repeated multiple times during a

session. Patients relaxed at the end of each yoga session, with 5 min of Shavasana.

Statistical analysis

Mean and standard deviations are calculated for each parameter. The appropriate tool for comparison of the change in the level of a variable was student's paired *t*-test for intragroup comparison; before applying this test, the Smirnov-Kolmogorov test was conducted to confirm the normality of each parameter. For all the variables, normality is confirmed. The level of significance is taken at 5%. Tables are constructed to show mean and standard deviation for the various parameters. Inference of significance is drawn on the value of *p*. Apart from comparing the various parameters of the data with respect to before and after yoga, comparison is made with respect to a control group. There are 51 persons in this group. To show that initially the two groups are on the same platform for each parameter, student's unpaired *t*-test is conducted for intergroup comparison. If the value of *P* is more than 5%, for any parameter, that shows there is no significant difference between the two groups.

Results

All the parameters of the data are quantitative variables. The main purpose of the study is to compare the levels of these parameters before initiating integrated approach of yoga therapy and after 6 months of practicing Integrated Approach of Yoga Therapy. Apart from comparing the various parameters of the data with respect to before and after yoga, comparison is made with respect to a control group. There are 51 prediabetics patients in both the groups. Table 2 showed that anthropometric profile in control and study groups.

Table 3 shows the age and gender distribution in different age groups. Majority of patients were between the age group 41–50 years and were females.

Table 4 shows mean values of blood glucose, lipid profile, and HbA1c for control and study groups. Results of blood glucose are highly significant ($P < 0.001$), HbA1c ($P < 0.01$) and lipid profile cholesterol ($P < 0.01$) and TG ($P < 0.01$), LDL ($P < 0.01$) are significant but HDL ($P < 0.02$) and VLDL not significant ($P < 0.03$) in study groups as compare to control group.

We observed decreased level of blood glucose, HbA1c, and lipid profile in study group as compared to control after yoga intervention. In control group, results were not significant.

Discussion

The Diabetes Prevention Program Research Group has published several studies showing that type 2 diabetes may be preventable by diet and exercise.^[8,17,18] An intensive lifestyle intervention focusing on weight loss did not

Table 1: Schedule of yoga practices

Yogic practices	Duration (min)
Prayer	3
Omkar recitation	3
Pranayama	5
Asanas (Surya Namaskar, Sukhasana, Bhujangasana, Pashimottanasana, Padmasana, Tadasana, Trikonasana, Sarvangasana, Ardhamatsyendrasana, Pawanmuktasana, Vajrasana, Dhanurasana)	30
Shavasana	5

Table 2: Anthropometric profile in control and study group

Baseline parameters	Control		Yoga		<i>P</i>
	Pre	Post	Pre	Post	
BMI	28.6±3	28.7±2	27.8±7	26.8±4	<0.001
Waist-hip ratio	90±6	92±6	91±7	85±4	<0.05

BMI=Body mass index

Table 3: Age and gender distribution of the study population

Age group (years)	Male	Female	Total
30-40	20	25	45
41-50	35	45	80
Total	55	70	125

Table 4: Intragroup comparison of results of biochemical parameters before and after in study group

Parameters	Biochemical parameters, mean±SD		<i>P</i>
	Before yoga	After yoga	
Fasting blood glucose	116.87±4.57	108.75±5.51	<0.0001
HbA1c	6.42±0.86	5.67±0.40	<0.01
TG	133.36±7.52	126.78±8.10	<0.01
Cholesterol	186.92±26.42	179.78±24.98	<0.01
HDL	44.88±3.22	46.28±2.35	0.02
LDL	115.36±4.52	108.14±4.2	<0.01
VLDL	26.67±1.504	25.36±1.62	0.03

Student's paired *t*-test used for intragroup comparison before applying this test the Smirnov-Kolmogorov test conducted to confirm the normality of each parameter. * $P < 0.01$ significant. SD=Standard deviation, TG=Triglyceride, VLDL=Very low-density lipoprotein, LDL=Low-density lipoprotein, HDL=High-density lipoprotein, HbA1c=Glycated hemoglobin

reduce the rate of cardiovascular events in overweight or obese adults with type 2 diabetes.^[19] This finding suggests there is a scope of introducing intervention programs in patients with prediabetes to save lives that may not occur in patients with diabetes. Lifestyle modification (LSM) is the most effective, cheaper and safer approach. LSM is from a pragmatic perspective, considered to be the primary line of intervention before any pharmacological

therapy for preventing the development of diabetes in high-risk individuals. Moreover, cohort studies like the 7-year project, involved in the Finnish DPS and the 20-year follow-up which was accomplished in the Da Qing Study, established that the beneficial effects of lifestyle intervention were sustainable.^[7]

The primary aim of lifestyle interventions is to prevent diabetes and its complications by targeting risk factor association with diabetes. Therefore, yoga was introduced as intervention in the study. The results of the present study show significant decrease in the blood glucose ($P \leq 0.001$) levels in the study group as compared to control group. In terms of blood glucose levels, our results are consistent with the results of Amita *et al.*^[20] and Gordon.^[21] An attempt to evaluate the effect of yoga on blood glucose levels in diabetes along with other risk factors has been made by these researches. Despite minor differences in the number of samples, time of exercise, and the individual characteristics of the individuals, their results were similar to our observations. The results of these studies suggest the positive effects of yoga on blood glucose levels that are consistent with our results. These results can be attributed to that muscle contraction and relaxation in asana and deep breathing in pranayama stimulate the pancreas gland, pancreatic cells, thus performing increases insulin secretion and regulation.^[21] Moreover, skeletal muscles have great ability in glucose uptake during exercise which is independent of insulin. Impact of exercise is to stimulate and reshape the GLUT-4 carrier of cell membrane from their intracellular storage location. Mechanisms of exercise are different messaging that rooted in an increase in calcium concentration caused by activation of the muscle fibers of the related motor neurons.^[22]

A significant decrease in the HbA1c ($P \leq 0.01$) has been observed in the present study as compared to the control group. Decrease in glycosylated hemoglobin in the yoga group is in accordance with the earlier study conducted by Malhotra *et al.*^[22] A significant improvement in glycosylated hemoglobin level, fasting glucose level, and serum lipid profile in yoga group compared to educational group has been reported earlier.^[23-25]

In the present study, significant decrease in the TC ($P < 0.01$), TG ($P < 0.01$) levels, and LDL ($P < 0.01$) was observed but HDL increases ($P < 0.02$) and VLDL ($P < 0.03$) decrease but not statistically significant relative to the control group.

However, an increase in HDL ($P < 0.02$) levels was observed but not statistically significant. The decrease in lipid profile observed in our study is in agreement with the earlier studies^[24,25] in reference to significant reduction in cholesterol and TG. The improvement in the lipid profile after yoga could be due to increased hepatic lipase and lipoprotein lipase at cellular level, which affects the metabolism of lipoprotein and thus increases uptake of TGs by adipose tissues.^[26,27] A 8-week, randomized, waitlist

controlled trial of yoga for prediabetes reported that yoga group had significant improvements in weight and waist circumference. Both groups improved in cholesterol and blood pressure, possibly due to the lifestyle session. There were trends toward improved glucose control on the OGTT and decreased insulin resistance.^[28]

Manjunatha *et al.*^[29] studied the effect of four sets of asanas in random order for 5 consecutive days and observed that the performance of asanas led to increased sensitivity of B cells of the pancreas to the glucose signal. They proposed that this increased sensitivity is likely to be a sustained change resulting from a progressive long-term effect of asanas. The mechanism of the antiglycemic activity of yoga exercise has yet to be described. A mechanism of neurohormonal modulation involving insulin and glucagon activity remains a possibility.

It has been reported that a yoga program would be a possible risk reduction option for adults at high risk for type 2 diabetes.^[30] In addition, yoga holds promise as an approach to reducing cardiometabolic risk factors and increasing exercise self-efficacy for this group. In our study among prediabetics with elevated fasting blood glucose, participation in an 12-week yoga intervention was feasible and resulted in greater weight loss and reduction in waist circumference when compared to a control. Yoga offers a promising lifestyle intervention for decreasing weight-related type 2 diabetes risk factors and potentially increasing psychological well-being. The feedback of most of the participants enrolled in our study and performing yoga asanas reported a feeling of wellbeing, more relaxed and satisfied, and a sense of relief from anxiety. They were more alert and active which could be due to release of opioids and altered adrenocortical activity. In yoga asanas change in posture and controlled breathing in pranayama influence neuroendocrinal balance, allaying apprehension, stress, and brings about feelings of well-being.^[31]

Stress is a potential contributor to chronic hyperglycemia in diabetes. Stress has long been shown to have major effects on metabolic activity. Energy mobilization is a primary result of the fight or flight response. Stress stimulates the release of various hormones, which can result in elevated blood glucose levels. In diabetes, as a result of the relative or absolute lack of insulin, stress-induced increases in glucose cannot be metabolized properly. Furthermore, regulation of these stress hormones may be abnormal in diabetes. Study supports the notion that stress reliably produces hyperglycemia in this form of the disease.^[32]

Yoga reduces the activation and reactivity of the sympathoadrenal axis and promoting feeling of well-being; yoga may alleviate the effect of stress and foster multiple positive downstream effect on neuroendocrine status, metabolic functions and related inflammatory responses and directly stimulating the vagus nerve; yoga may enhance parasympathetic output and thereby shift the autonomic

nervous system balance from primarily sympathetic to parasympathetic leading to positive change in cardiovagal function in mood and energy state and in related neuroendocrine, metabolic, and inflammatory response.^[26]

In view of the findings of the study, an intervention to prevent prediabetes from progressing to diabetes may prove beneficial.

Conclusion

The study clearly indicates that yoga is a potential intervention strategically targeting prediabetics and should be the cornerstone for diabetes prevention. It is a low-cost, easily accessible lifestyle management program which holds promise as an approach to reducing cardiometabolic risk factors and increasing exercise self-efficacy for prediabetics performing yoga. The findings of this study need to be explored in larger trials involving prediabetics.

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Conflicts of interest

There are no conflicts of interest.

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