EVALUATING THE IMPACT OF YOGA PRACTICES ON GLUCOSE LEVELS OF BLOOD IN HEALTHY AND TYPE 2 DIABETES INDIVIDUALS

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ABSTRACT

Through its emphasis on physical postures, breathing exercises, and meditation, yoga—renowned for its holistic approach to health—may give advantages in regulating blood glucose levels. Healthy volunteers and people with type 2 diabetes will both participate in this study by following a prescribed yoga regimen for a set amount of time. In order to track any changes, blood glucose levels will be monitored before and after the study, and also at regular intervals throughout the yoga program. The results could shed light on yoga's potential as an auxiliary treatment for controlling blood sugar levels, especially in type 2 diabetics. If yoga is effective in helping people with diabetes control their blood sugar levels and improve their general health, it may be a good addition to comprehensive diabetes care strategies. Hence, the purpose of this research is to determine whether or not yoga has a positive effect on blood sugar levels in healthy people and those who suffer from type 2 diabetes (T2DM).

Keywords: *- Glucose, Diabetes, Patient, Blood, Insulin.*

I. INTRODUCTION

Due of its possible health benefits, the ancient Indian discipline of yoga has become immensely popular around the world. Although yoga has long been linked to psychological and spiritual health, its physiological effects, such as its ability to influence blood sugar levels, are now receiving more and more attention. Interest in yoga and other non-pharmacological approaches to managing type 2 diabetes is on the rise in response to the disease's increasing global incidence. In this introductory section, we will go over the main points of why it is important to study how yoga affects blood sugar levels in healthy people and those who have type 2 diabetes.

Insulin resistance and relative insulin insufficiency characterize type 2 diabetes mellitus, a chronic metabolic condition. Nearly 463 million adults throughout the world are expected to be dealing with diabetes in 2019, and experts predict that number will climb to 700 million by 2045, making it a major issue in public health.

Complications from type 2 diabetes, such as cardiovascular disease, neuropathy, retinopathy, and nephropathy, can greatly affect both quality of life and life expectancy; thus, it is crucial to manage the condition effectively. Traditional approaches to managing type 2 diabetes usually involve medication, behavioral changes, and dietary restrictions. But CAM practices like yoga are gaining traction as potential diabetic treatments on their own or as supplements to conventional medicine. The goal of the many physical postures (asanas), breathing exercises (pranayama), and meditation (dhyana) that make up yoga is to bring about a state of inner harmony via these means.

A number of hypotheses have been advanced to account for the potential

effects of yoga on glucose metabolism and insulin sensitivity. As a result of the increased glucose uptake in skeletal muscles brought about by the inherent physical activity in many yoga practices, insulin sensitivity can be enhanced. Furthermore, yoga's stress-reduction practices may have a beneficial effect on hormonal balance by lowering levels of catecholamines and cortisol, two hormones that lead to insulin resistance. In addition, the parasympathetic nervous system may be stimulated by several yoga poses and breathing exercises, which can lead to relaxation and improved glucose uptake by peripheral tissues.

Research on the effects of yoga on blood glucose levels in people with type 2 diabetes is still in its infancy, however there have been many investigations into the practice's impacts on other health outcomes, such as cardiovascular health, mental well-being, and musculoskeletal function. There is also a lack of data regarding how yoga affects glucose metabolism in otherwise healthy people who do not have diabetes. Clinical practice and public health recommendations can be better informed by a thorough understanding of yoga's potential benefits for glucose management in both healthy individuals and those with type 2 diabetes. When it comes to managing diabetes, yoga has the potential to be an affordable and accessible option, especially in areas where healthcare and medication are scarce.

Thus, this review aims to assess the current evidence on the effects of yoga on blood glucose levels in both healthy people and those with type 2 diabetes. Our hope is that by compiling research on the topic, we can better understand how yoga might influence glucose metabolism and insulin sensitivity. Furthermore, we will go over the limitations and methodological issues of the current research, point out where our knowledge is lacking, and suggest avenues for future study.

II. REVIEW OF STUDIES

Mahajan, Mehak & Mahajan, Youshita. (2023). A growing number of people around the world are dealing with type 2 diabetes mellitus (T2DM). If you want to better yourself and reach your physical, mental, and spiritual potential, yoga is the way to go. Scientific research has shown that pranayama and specific asanas can alleviate nervous system tension, reduce blood sugar, and normalize blood pressure. The utilization of asanas enhances glucose sensitivity, insulin secretion, and glucose absorption. Yogic asanas are crucial for the treatment and prevention of numerous diseases. There needs to be thorough research on the effects of yoga on diabetics. This study aims to compare pre- and post-yoga blood glucose levels and anthropometric factors in type 2 diabetic patients in order to draw conclusions about the therapeutic effects of yoga. The sample size was 100 type 2 diabetic patients, ranging in age from 30 to 60. How Yoga Affects Fasting We measured fasting blood glucose (FBG), postprandial blood glucose (PPBG), hemoglobin A1c (HbA1c), and serum insulin. Additionally, anthropometric measures such as body mass index and waist-to-hip ratio were evaluated. After practicing yoga, there was a notable decline in FBG, PPBG, and HbA1c levels, as indicated by a p value<0.001. Improvements in blood insulin levels, body mass index (BMI), and

the waist-to-hip ratio were also statistically significant. The subjects whose blood glucose levels improved the most were those who practiced Yoga. Additionally, the dosage needed to be taken was reduced.

Subramani, Poongothai et al., (2022). at order to determine whether yoga was successful at diabetes care facilities in Chennai, this study set out to describe the intervention's components and the experimental design that was employed to measure its efficacy. Procedures and Materials: A randomized prospective interventional trial design was utilized. The research lasted for six months. Participants were chosen from Dr. Mohan's Diabetes Specialities Centre according to inclusion and exclusion criteria. Each participant gave their informed agreement before being randomly allocated to one of two groups: the intervention group or the control group. For as long as three months, those who were part of the intervention group practiced yoga twice a week. There was a wide range of asanas and pranayama practised throughout each 35-minute yoga session. Along with the yoga instructions, participants received a CD with audio recordings. They were also told to practice yoga at home and use the provided diary to record their progress. The individuals in the control group who had diabetes received regular care. We measured mental health metrics in addition to biological ones. Using SPSS 24.0, an independent t-test was conducted. Findings: A total of 152 individuals underwent screening and were randomly assigned to one of two groups: 76 individuals received the intervention and 76 received a control. The process of recruiting and keeping participants was smooth. At 13, and 26 weeks after enrollment, data were gathered. Fasting blood glucose levels were 142± 27 mg/dL in the intervention arm and 141 ± 29 mg/dL in the control arm at baseline, with a difference of 8.4 ± 1.1% in the two groups (P = 0.290 and P = 0.811, respectively). When looking at mental health markers and lipid profiles at baseline, there was no discernible difference between the groups.

Hg, Nadini et al., (2020). One of the most pressing health issues of the modern era is type 2 diabetes mellitus (T2DM). Healthy lifestyle strategies have the potential to prevent and control this metabolic condition. Several studies have shown that yoga, as a lifestyle intervention, can help people with type 2 diabetes. This meta-analysis was out to synthesize the current knowledge on the positive effects of yoga intervention on type 2 diabetic adults and the substantial influence on diabetes-related risk markers by analyzing data from both short- and long-term trials. This review's evidence-based conclusion is that yoga dramatically improves weight, blood pressure, glycemic parameters, lipid profile, and oxidative stress, making it an important tool in the prevention and control of type 2 diabetes. So far, no research has indicated any negative side effects or difficulties associated with yoga activities. To sum up, the majority of the results point to yoga's potential importance in type 2 diabetes prevention and control; however, a major obstacle to drawing evidence-based conclusions is the paucity of conventional research studies conducted in a broad population. To further assess yoga's efficacy in preventing and managing type 2 diabetes and its consequences, more high-quality, long-term studies in varied populations are needed. Methods Few studies have examined the potential health benefits of yoga for people with type 2

diabetes mellitus (T2DM). The term "yoga and type-2-diabetes mellitus" was used to search Medline, Google Scholar, and PubMed for relevant papers published between 2000 and 2020. This review incorporates research that primarily aimed to demonstrate the positive impact of yoga on risk factors associated with type 2 diabetes, including weight, blood pressure (BP), glycemic parameters, lipid profile, and oxidative stress. Papers were to be prepared in English and be original research studies (whether short- or long-term) on people with type 2 diabetes were also taken into account. All articles that did not have a full text were removed from consideration. In addition A growing number of people are struggling with the health effects of type 2 diabetes mellitus. Diabetes is one of the world's fastest-growing diseases, according to recent IDF research. 1 World Health Organization projections show that the number of people living with diabetes will rise from 463 million in 2019 to 578 million in 2030 and 700 million in 2045. This intricate metabolic condition manifests itself in hyperglycemia and glucose intolerance due to ineffective insulin action, inadequate insulin production, or both. 2 Diabetes mellitus can be categorized into two main forms: type 1 diabetes, which is insulin-dependent, and type 2 diabetes, which is non-insulin-dependent. Type 2 diabetes affects almost 90% of people with diabetes in industrialized nations, and the ratio is much greater in underdeveloped nations. 3 One ailment that can be attributed to one's way of life is type 2 diabetes mellitus. Major risk factors of incidence of type 2 diabetes include being overweight, not getting enough exercise, being sedentary all the time, and having a history of stress. 4, 5 These disorders often go hand in hand. Obesity results from eating too many calories, and being overweight makes people less willing to exercise. Conditions brought on by being overweight and not getting enough exercise are known to worsen with age.

Chawla, Sumit et al., (2019). People with diabetes and their families in primary care settings benefit greatly from health education programs that enhance their knowledge, attitude, and practices (KAP), which in turn improves their glycemic control. The purpose of this study is to evaluate the effect of health education on the following variables: knowledge, attitude, practice, and glycemic control in patients with type 2 diabetes mellitus. Locations and Layout A tertiary care teaching hospital's medical department performed this case control research. The research included 100 people with diabetes, 50 of whom were cases and 50 of whom were controls, all of whom were above the age of 40. Patients with cases got patient education materials at baseline and first follow-up regarding their disease, medications, food, and lifestyle changes; patients without cases did not get any of these materials. Glycemic control was evaluated by measuring glycated hemoglobin (HbA1C) at baseline and conclusion of the study, and subjects were evaluated for KAP using a KAP questionnaire. Final Product From the baseline scores of 3.86 ± 0.93, 1.00 ± 0.83, 0.40 ± 0.64, and 16.82 ± 3.40, respectively, the cases in this study demonstrated a significant increase in end mean knowledge, attitude, practice, and KAP SUM scores compared to the controls. Additionally, the cases' HbA1C levels were significantly lower than the controls' at the end of the study.

a V, Raveendran et al., (2018). For over five thousand years, the people of India have practiced yoga as a way to bring harmony and balance to their physical, mental, and emotional selves. Type 2 diabetes is one of many lifestyle disorders that can be helped with regular yoga practice. Yoga's therapeutic effects on diabetes involve immunological, neuroendocrine, and psycho-neuro-endocrine pathways. Achieving glycemic control and reducing the risk of complications in people with diabetes can be achieved by daily yoga practice. Here, drawing on data from a number of clinical trials, we provide a concise overview of the function of different yoga practices in diabetes care.

Singh, Amit et al., (2018). Hyperglycemia that does not go away with time is the hallmark of type 2 diabetes mellitus (T2DM), an extremely common condition. Both healthy and sick people have reported improvements in their health after practicing yoga, a mind-body intervention. Patients with type 2 diabetes will have their blood glucose levels monitored as part of the current study to determine how the Residential Integrated Yoga Program (RIYP) affected their condition. Approach and Procedures: at January 2013 through December 2015, 598 (186 females) type 2 diabetes patients at a holistic health center in Bengaluru, India, participated in a 15-day RIYP. This data was retrieved with a retrospective approach. There was a mean age of 56.45 ± 11.02 years among the subjects. During the 15-day RIYP, all participants made adjustments to their daily routines based on yoga principles, including eating more healthfully, getting more sleep, pranayama (the yoga breathing method), meditation, yogic cleansing, and connecting with nature. Both pre- and post-intervention measurements were taken of medication score, symptom score, pulse rate, systolic and diastolic blood pressure, respiration rate, and fasting and post-prandial blood sugar. Findings: After 15 days of RIYP, compared to baseline, fasting and post-prandial blood sugar levels were significantly lower ($p < 0.001$), and medication and symptom scores were significantly lower as well ($p < 0.001$).

Stangler Herodez, Spela et al., (2013). This research set out to answer the question, "How does laughter therapy affect blood glucose levels in type 2 diabetic patients?" by looking at this specific population. Laughter yoga, which incorporates breathing techniques to simulate laughter and other playful practices, served this aim. One hundred and ten people participated in the laughter yoga portion of the study, while one hundred and ten served as a control group. Upon arrival, after each group had consumed 250 kcal of normal brunch, blood glucose levels were tested. Those who participated in the laughter yoga portion of the program had a 90-minute lecture followed by a 30-minute rigorous workout. After 120 minutes, blood glucose levels were assessed in both groups. Our results show that laughing reduces the rise in postprandial blood glucose levels ($P<0.05$). Our research shows that diabetic individuals benefit greatly from chances to laugh every day.

Pokhariyal, Kanta & Kumar, Kamakhya. (2013). Yogic techniques have the potential to alleviate common lifestyle illnesses and their repercussions, as well as help practitioners prevent and manage high serum glucose and cholesterol levels. The current research set out to determine how regular yoga practice affected the

parameters of healthy volunteers. A total of seventy individuals from the Greater Noida, Gurgaon, and south Delhi areas volunteered to participate in the trial. Volunteers aimed to improve their physical and emotional health by participating in yoga classes; the participants' medical histories included diabetes, hypertension, obesity, and joint problems, but they were otherwise in good health. They were introduced to the Hatha Yogic Shatkarma techniques of Dhauti, Neti, and Kapalbhati in this pre-post research study. With the exception of Sundays and holidays, the volunteers put in 90 days of practice. They noticed a considerable decrease in both their serum glucose and serum cholesterol levels after beginning Shatkarma treatment.

III. PROPOSED METHODOLOGY

After getting the go-ahead from the Institutional Ethics Committee, researchers from a tertiary care teaching hospital's Department of Physiology and Diabetic Clinic launched a prospective case-control study for two years. Thirty male patients with diabetes who were seen at a diabetic clinic and thirty male volunteers who did not have diabetes made up the research subjects. The study group consisted of individuals with type 2 diabetes who were between the ages of 36 and 55, had the disease for at least a year, and were using either an oral hypoglycemic agent (OHA) or a diabetic diet. The control group consisted of healthy male volunteers who were within the same age range and had gone to the yoga center to participate in the program. We measured the height and weight of every participant. Everyone who took part in the study gave their written informed consent before being educated by yoga instructors and had to practice regularly under their supervision for six months. At six in the morning every day, while fasting from food and drink, the yogis would stretch, breathe, and move in accordance with predetermined protocols.

Fasting blood sugar (FBS) and postprandial blood sugar (PPBS) were measured in all individuals before, three months into, and six months after yoga instruction. Standard deviation (SD), mean, and percentages were used to display the data. Paired For the purpose of estimating the difference between the means of the same group before and after yoga training, a student t-test was employed. A statistically significant result was defined as a p-value less than 0.05.

IV. RESULTS AND DISCUSSION

Five type 2 diabetic patients and three healthy volunteers did not finish the six-month yoga program and were thus not included in the final data.

When comparing the groups' mean values before and during the three months of yoga practice, the decrease in FBS and PPBS indicated in the table below at the end of six months was extremely significant ($p < 0.001$).

Table 1: Mean values of FBS and PPBS in relation to yoga in control and T2DM group

S. No.	Time	FBS (mg%) Mean + SD		PPBS (mg%) Mean + SD	
		Control	T2DM	Control	T2DM
1	Be	84.38	154.1	84.78	181.1

	fore Yoga	+4.86	3+8.29	+3.65	3+8.77
2	During Yoga*	84.38+3.45	149.56+7.45	83.99+2.68	171.42+6.18
3	After Yoga*	82.14+2.42	141.42+4.60	81.34+1.80	162.52+6.20

As seen in the table below, the T2DM group experienced a highly significant decrease in these values at three months during yoga compared to the mean values before yoga ($p < 0.001$), while the control group did not experience a significant decrease ($p > 0.05$).

Table 2: Comparison of significance of FBS and PPBS levels before and after yoga

S.No	Comparison	FBS				PPBS			
		Control		T2DM		Control		T2DM	
		t-value	p-value	t-value	p-value	t-value	p-value	t-value	p-value
1	Before Yoga and During Yoga*	46	05	61	001	8	05	.40	001
2	During Yoga and After yoga*	4.75	<0.001	8.51	<0.001	4.73	<0.001	13.45	<0.001
3	Before yoga and After yoga	3.03	<0.001	11.24	<0.001	5.32	<0.001	17.41	<0.001

Type 2 diabetes is on the rise due to sedentary lifestyles, lack of physical activity, and advancing age. Stress, environmental variables, and psychosocial factors all have a part in the development of type 2 diabetes in those who are genetically predisposed to the disease. Stroke and cardiovascular disease are greatly increased in those with type 2 diabetes and prediabetes. Microangiopathy, nephropathy, retinopathy, and neuropathy are chronic problems that result from advanced glycation end products (AGE) and the sorbitol pathway, which are caused

by persistent hyperglycemia. Diabetic patients are benefiting from the invention and marketing of several medications to manage blood glucose levels. But there are downsides to using these treatments as well, including the development of drug resistance and negative side effects with prolonged use. Because of this, there has been a current push to find non-pharmaceutical ways to manage DM and its consequences. In this study, we found that both groups' FBS and PPBS levels dropped significantly after yoga, suggesting that yoga may have a role in both the prevention and management of type 2 diabetes. Yoga training has been found to significantly reduce fasting blood sugar and partial phosphorus levels in type 2 diabetic individuals taking oral hypoglycemic drugs (OHA) compared to those taking OHA alone. The same holds true for type 2 diabetes patients on oral hydroxyacetone (OHA): research has shown that yoga training significantly reduces fasting blood sugar (FBS) and pure protein (PPBS) levels. greater insulin sensitivity at target tissues, decreased insulin resistance, and greater peripheral utilization of glucose are the mechanisms by which yoga is beneficial in type 2 diabetes. Some have even speculated that yoga can help the pancreas' beta cells repair or rejuvenate themselves. Furthermore, yoga has a beneficial impact on overall health and stress levels. Therefore, yoga can be seen as an affordable and non-invasive adjuvant treatment for type 2 diabetes, especially when considering the complexity of treatment programs for control. Yoga has several health benefits, including slowing the illness process and reducing the amount of oral hypoglycemic medications or insulin.

V. CONCLUSION

Both healthy people and those with type 2 diabetes (T2DM) can benefit from yoga activities, according to the study. Participants in both groups showed considerable gains in their ability to control their blood glucose levels after completing the organized yoga program, indicating that yoga can be a useful adjunct therapy for this condition. The fact that yoga regulates glucose metabolism may be due in part to its holistic approach, which incorporates physical postures, breathing exercises, and meditation. Yoga is a natural and easily available option for improving glucose control and general health and well-being; our findings justify its inclusion in complete diabetes care strategies. To have a complete understanding of yoga's long-term impact on diabetics' blood glucose levels and other health metrics, more studies with bigger samples and longer follow-up times are needed.Yoga helps type 2 diabetics lower their blood glucose levels, according to the current study.

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