

INFLUENCE OF REGULAR YOGA PRACTICE ON SLEEP QUALITY, BLOOD PRESSURE, AND GLYCEMIC CONTROL IN TYPE 2 DIABETES MELLITUS

NATESAMURTHY V^{1*}, DR. R. MOHANAKRISHNAN²

¹PH.D. RESEARCH SCHOLAR, DEPARTMENT OF YOGA, SRM INSTITUTE OF SCIENCE AND TECHNOLOGY, FACULTY OF SCIENCE AND HUMANITIES, KATTANKULATHUR, TAMILNADU, INDIA. ORCID: <https://orcid.org/0009-0006-6278-6354>

²RESEARCH SUPERVISOR, DIRECTOR OF SPORTS, DEPARTMENT OF PHYSICAL EDUCATION AND SPORTS SCIENCES, SRM INSTITUTE OF SCIENCE AND TECHNOLOGY, FACULTY OF SCIENCE AND HUMANITIES, KATTANKULATHUR, TAMILNADU, INDIA. ORCID: <https://orcid.org/0009-0003-9291-6795>

Abstract

The most common metabolic disease in the world that targets many organs and has a major negative impact on quality of life is diabetes. Type 2 diabetes mellitus (T2DM) is the most prevalent kind, strongly associated with increased stress levels caused by dietary and lifestyle changes such as inadequate vegetable intake, alcohol drinking, and tobacco use. Psychosocial variables such as stress, anxiety, sadness, sleep, blood pressure, glycemic control, and quality of life have been closely linked to T2DM. Yogic practice on a daily basis may help improve T2DM control. The main advantage of yoga practice is that it can help people stay healthy, and it also improves the regulation of blood glucose. This study aimed to examine the influence of regular yoga practice on sleep quality, blood pressure, and glycemic control in T2DM. To achieve the purpose of this study, two groups were randomly assigned to participants with T2DM who were seen at a diabetic tertiary care centre. With 120 subjects, the Control group (non-Yoga) (n = 60) was encouraged not to engage in any activities, the Experimental Group (Yoga) (n = 60) received training and instruction to perform yogasanas for 60 minutes four days a week during a 12-week period, and their age group was between 45 and 60 years. For twelve weeks, the EGs will receive their corresponding instruction for an hour every day, three days a week. Glycemic control, blood pressure, and sleep quality were measured both before and after the experimental test. Blood glucose, HbA1c, SQI (Pittsburgh Sleep Quality Index), actigraphy, and systolic/diastolic blood pressure were all significantly lower in the yoga group than in the non-yoga group. Blood pressure, glycemic control, and sleep quality all significantly improved in those who practiced yogasanas. Subjects with T2DM who regularly performed Yogasanas experienced improvements in glycaemic control, oxidative stress, sleep quality, and inflammatory response. Therefore, Yogasanas can be used as an effective auxiliary method for controlling T2DM.

Keywords: Yoga Practice, Blood pressure, Yogasanas, type 2 diabetes, glycemic control, sleep quality

1. INTRODUCTION

A common metabolic disease, type 2 diabetes mellitus (T2DM), is characterized by persistent hyperglycemia [1]. It is caused by two major factors: the inability of insulin-sensitive tissues to appropriately respond to insulin and defective insulin synthesis by pancreatic β -cells. Inadequate glycemic control in individuals with T2DM is a key risk factor for the development of diabetic complications and a substantial public health concern [2]. Glycemic control is the primary objective for avoiding organ damage and other health related problems associated with diabetes. Rapid changes in people's lifestyles, particularly in terms of physical inactivity, raise metabolic difficulties and lead to T2DM problems. The International Diabetes Federation (IDF) reports that the number of diabetes cases worldwide will rise from 643 million in 2030 to 783 million by 2045 [3].

Yoga is a way of life and an ancient pre-Vedic science [4]. Yoga was first practiced more than 5000 years ago in ancient India. Its primary goal is to improve a person's psychophysiological health. Yoga encompasses certain philosophical principles as well as moral observances (Yama), sensory withdrawal (Pratyahara), self-disciplines (Niyama), physical postures (Asana), self-realization (Samadhi), voluntarily controlled breathing (Pranayama), meditation (Dhyana), and concentration (Dharana). The yoga module involved quick relaxation methods starting with warm-up exercises for shoulders, legs, spine, and neck, [5] and then asanas such as Trikonasana, Thadasana, Konasana, Vajrasana, Uttanapadasana, Patchimothasana, Matchyasana, Sarvangasana, Pranayama, and Salabhasana involving Brahmari relaxation, abdomen breathing, Nadisudhi, Kabalbhathi and Sitali techniques. Regular yoga practice at the appropriate scientific dosage can help regulate a variety of lifestyle conditions [6], including T2DM. Regular yoga practice lowers oxidative and mental stress and helps achieve glycemic control.

Numerous studies show that regular exercise, such yoga, enhances glycemic control and has a positive impact on metabolic activity.

Poor sleep quality increases systemic inflammation and results in increased stress levels. Post-yoga intervention has been proven to help lower oxidative stress levels in patients with T2DM. A yoga intervention for 12 weeks also decreased insomnia [7]. Yoga is believed to help reduce oxidative stress and inflammation, which are connected to chronic diseases like diabetes, while the precise mechanism of action behind its beneficial effects like diabetes [8]. According to yoga philosophy, the majority of diseases are caused by either an insufficient life energy as a whole or a blockage of life force in a specific area of the body [9], which lowers immunity and makes a person more vulnerable to infections. One of the main goals of yoga is to address the primary reason rather than just the symptoms [10]. Yoga may assist diabetic patients in managing their blood sugar levels, reducing stress, and enhancing their overall quality of life (QOL).

In this study, we investigate the influence of regular yoga practice on sleep quality, blood pressure, and glycemic control in T2DM. To achieve the purpose of this study, two groups were randomly assigned to participants with T2DM who were seen at a diabetic tertiary care centre. While the Control group (non-Yoga) (n = 120) was encouraged not to engage in any activities, EG (Yoga) (n = 120) received training and instruction to perform yogasanas for 60 minutes four days during a 12-week period. For twelve weeks, the EGs will receive their corresponding instruction for an hour every day, three days a week. Glycemic control, blood pressure, and sleep quality were measured both before and after the experimental test. Blood glucose, HbA1c, SQI (Pittsburgh Sleep Quality Index), actigraphy, and systolic/diastolic blood pressure were all significantly lower in the yoga group than in the non-yoga group. Blood pressure, glycemic control, and sleep quality all significantly improved in those who practiced yogasanas. Subjects with T2DM who regularly performed Yogasanas experienced improvements in sleep quality, oxidative stress, inflammatory response, and glycaemic control. Therefore, Yogasanas can be used as an adjuvant therapy for controlling T2DM betes.

2. RELATED WORKS

Viswanathan et al [11] examine how yoga interventions affect T2DM participants' biochemical, oxidative stress, and inflammatory indicators as well as their sleep quality. Participants with T2DM who visited a diabetic tertiary care facility in Chennai, India, between February 2017 and October 2019 were split into two groups at random. Group 1 (non-yoga) (n = 150) received basic physical exercise advice, while Group 2 (yoga) (n = 150) received training and instructions to perform yoga poses and static stretches for 50 minutes five days a week. For a duration of three months, both groups were monitored. At baseline and following follow-up, anthropometric, inflammatory, metabolic, sleep quality, and oxidative stress measures were evaluated. In contrast with the non-yoga group, the yoga group showed a substantial decrease in blood lipid levels, BMI, HbA1c, IL6, TBARS, glucose levels, and TNF α . Subjects performing yoga poses demonstrated a significant enhancement in their PTGIS, Adiponectin, and sleep quality levels.

Vidyashree et al [12] examine the impact of 3 month yoga intervention tailored to diabetes on individuals with T2DM in terms of better sleep and less anxiety. Salivary cortisol levels in people with T2DM were also assessed. Additionally, there was a relationship between salivary cortisol levels and glucose levels, concern levels, and sleep quality. Based on the eligibility criteria, participants in this randomized controlled trial (RCT) were assigned at random to the yoga group and CG. For three months, the yoga group received a T2DM-specific yoga intervention, while the CG continued to receive standard medical care. 63 (84%) of the 75 members were men, 38 practiced yoga, and 37 were in a CG. Their mean age was 51.5 ± 9.8 years. The yoga group's mean HbA1c (%) was 7.95 ± 1.27 , while the CGs were 7.6 ± 1.17 . Repeated-measure, the statistical changes were analyzed using ANOVA. Our study's findings illustrated that the yoga group significantly improved sleep quality and simultaneously reduced worry.

Sriwahyuni et al. [13] assess how well yoga poses can lower blood sugar levels in individuals with T2DM. With a non-equivalent CG method and a CG that is not treated with the same pre- and post-treatment samples (paired samples), this study design is a quasi-experimental analytical investigation. GDS levels before and after yoga activity differed significantly, according to the data. The mean values of GDS level, which dropped by 74.25 mg/dL following yoga activity, supports this. It may be determined that yoga activity is effective in lowering GDS levels in T2DM patients because of the intervention's correlation strength of 0.965. It was determined that the GDS levels before and after yoga activity differed significantly. It is advised that people with T2DM receive instruction about increasing their physical activity as a non-pharmacological treatment to maintain normal blood sugar levels.

Subramani et al. [14] examine how a yoga intervention affects the mental and physical well-being of persons with T2DM. For six months, this experiment was carried out at the Madras Diabetes Research Foundation in Chennai. Participants were recruited who were between the ages of 18 and 65, had a diagnosis of T2DM, and had HbA1c levels between 7.0 and 10.5%. A simple random approach was used to assign 152 individuals in a 1:1 ratio to either the control arm or intervention. For 12 weeks, the intervention consisted of 35 minutes of structured yoga practice every two weeks, with a 3-month follow-up. Individuals in the CG were given the usual diabetes treatment. Blood samples, anthropometric measurements, and sociodemographic information were gathered

during the baseline and final visits. To evaluate mental health parameters, standard questionnaires were used. The trial was finished by 70 of 76 (92%) persons in the control arm and 53 of 76 (70%) participants in the intervention arm. The individuals were 53 ± 7.5 years old on average. The individuals' average duration of diabetes was 10 ± 6.9 years. Although there was a decrease in HbA1c after the intervention, it was not significantly improved than the EG. When compared to the CG, the intervention group demonstrated statistically significant developments in stress, depression, mindfulness, and cognitive performance.

Menek and Budak [15] assess how an integration of aerobic and strengthening exercises affects people with T2DM in terms of their sleep quality, muscle strength, and balance, as well as their HbA1c. This study included 50 people with T2DM who were between the ages of 30 and 65. Anthropometric measures, quadriceps and hamstring strength, HbA1c, balance, and sleep quality were evaluated for the enrolled persons. For 12 weeks, the participants engaged in aerobic and strengthening workouts three days a week. Sixty-four percent ($n=32$) of the 50 participants with T2DM who were diagnosed were men, and 36 percent ($n=18$) were women. All subjects' assessments of muscle strength, balance, sleep quality, and HbA1c before and after treatment showed statistically significant differences ($p<0.001$). Long-term strengthening and aerobic exercise was found to dramatically enhance sleep quality, muscle strength, and balance in those with T2DM while simultaneously lowering the HbA1c value. Developing the most appropriate and successful exercise training in terms of sustainability and efficiency for people with T2DM would benefit from an organized training program that incorporates both strengthening and aerobic exercises.

3. MATERIALS AND METHODOLOGY

The present study was a controlled, randomized experiment. The EG consisted of sixty people, while the control group also included sixty people. The study aims to examine the effect of regular yoga practice on sleep quality, blood pressure, and glycemic control in T2DM after three months. Figure 1 shows the working strategy of the proposed method.

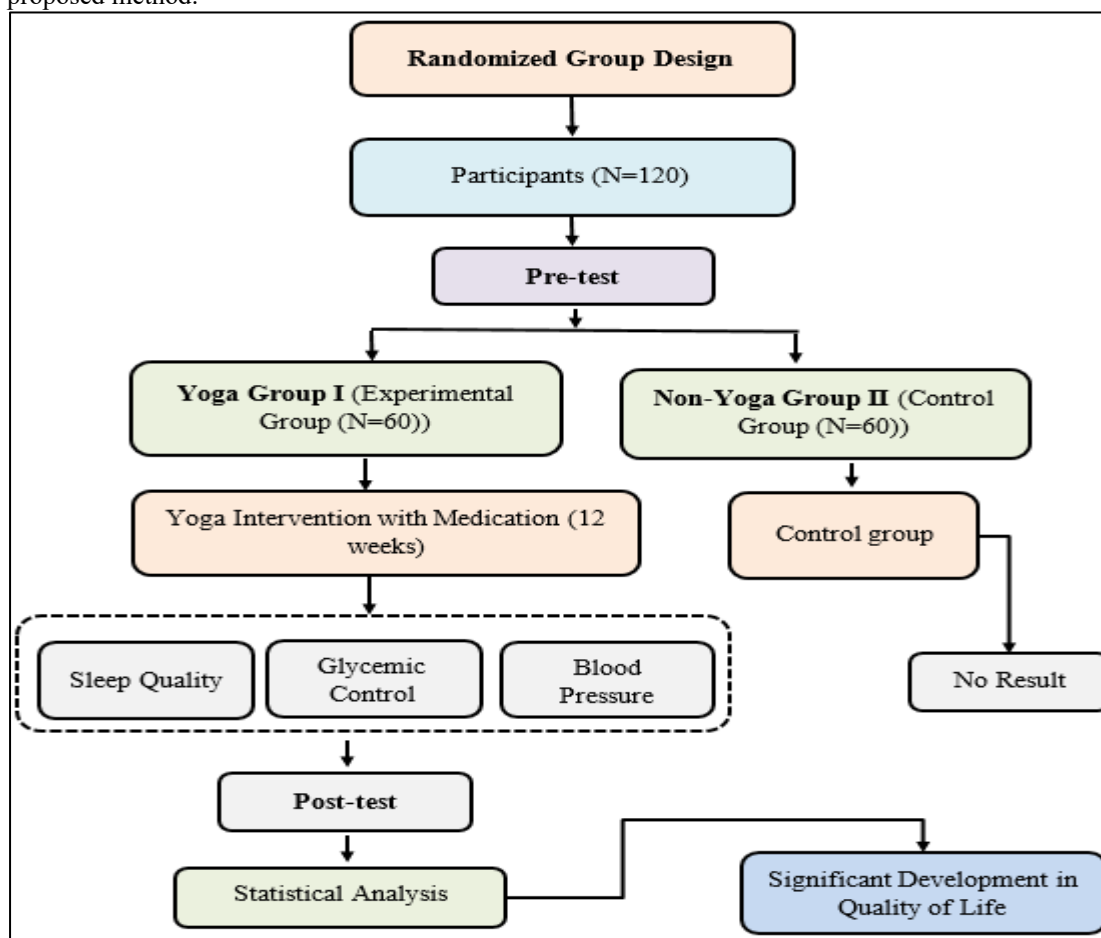


Figure 1. Working process of the proposed method

3.1. Work strategies

This study involved 120 people with T2DM, of which 60 were in the EG (Yoga Group) and the remaining 60 were in the CG (Non-Yoga Group). The EG consisted of people who took medicine and practiced yoga exclusively. In contrast, the CG consisted of people who did not take any further precautions and merely took their medication. The criteria for inclusion and exclusion were used to choose the candidates.

3.2. Criteria for Inclusion

The following were among the inclusion criteria for this study: People with T2DM at the time of the study, people between the ages of 30 and 50, and people taking oral hypoglycemic medications.

3.3. Criteria for Exclusion

The following were the exclusion criteria. Those under thirty or over fifty years old, Regular yoga practitioners, athletes, and patients participating in an alternative kind of exercise, expectant mothers, Previous history of chewing tobacco, smoking, and consuming alcohol, a history of TB sickness, chronic obstructive pulmonary disease, and respiratory infections during the last six weeks.

3.4. Analytical Biochemistry

Glycemic parameters, blood collection, and serum sample collection are the basic criteria used in biochemical research.

3.5. Analytical Statistics

SPSS 18 was used for statistical analysis of the results. To determine if the two courses differed, the unpaired t-test was employed. A paired t-test is used to define and evaluate P-values for both the CG and EG before and after the experiments. It was determined that $P < 0.001$ was statistically significant. $P < 0.05$ is considered significant, whereas $P > 0.05$ is not.

3.6. Pre-Intervention

Group 1 ($n = 60$) received a yoga intervention recommendation and was told to do it five days a week for sixty minutes each day. Group 2 was instructed to perform basic activities for 50 minutes five days a week. A yoga instructor trained every subject in both groups. Each participant received education on diabetes, its risk factors, consequences, and the value of yoga in preserving glycaemic control, blood pressure, and sleep quality and averting diabetes-related problems during the first session. Additionally, participants received 20 minutes of static stretching exercises and 30 minutes of instruction in yoga poses using a different yoga program. The subjects received this instruction one-on-one, practicing under the yoga instructor's guidance until they were able to complete the module independently. They were later instructed to repeat the same yoga exercise at home five days a week. Before moving on to asanas like Trikonasana, Thadasana, Konasana, Vajrasana, Sarvangasana, Patchimothasana, Uttanapadasana, Matchyasana, Pranayama, Salabasana, and which includes breathing exercises for the abdomen, Nadisudhi, Kabalbhati, Sitali, and Brahmari relaxation techniques, the yoga module included quick relaxation techniques. As they practiced at home, they were also told to call the yoga instructor if they needed any clarification on the poses. The researcher called the participants once every two nights to encourage them to keep up their yoga and exercise routines and to make sure they were adhering to diabetes research and clinical practice. Few people needed the second session to understand the poses and become fully capable of doing them on their own. A small number of participants had made video calls to the yoga instructor during their first session to certify that they were performing the poses correctly. Hypoglycemia and other incidents that occurred throughout the study period were also documented. Every study participant was monitored for three months, and at the conclusion of the study period, every study parameter was evaluated. Throughout the trial time, the medications remained the same. For the final analysis, 120 participants in total—60 in each of the two groups, EG (37M:49F) and CG (30M:50F)—were included after the dropouts were eliminated.

3.7. Post - intervention

After three months, the participants from both groups underwent their final evaluation. Blood pressure, BMI, metabolic parameters, weight, inflammatory indicators, stress markers, and sleep quality were all evaluated during the pre-test.

3.8. Statistical Analysis

The median (interquartile range) for cholesterol, HbA1c, and glucose levels was presented due to the skewed nature of the data distribution. For blood pressure, BMI, and weight, the mean and standard deviation were given. Details about medicine use, alcohol consumption, and smoking habits were given, along with their numbers and percentages. To inspect the influence of the intervention within the groups, paired t-tests were used. Categorical variables were subjected to the chi-square test. Prior to analysis, all oxidative stress and inflammatory indicators underwent log transformation.

4. RESULTS AND DISCUSSIONS

Using a random selection technique, 60 of the 120 participants in the study were selected to serve as the EG and CG. Individuals in the EG received yoga therapy in addition to their prescription, whereas those in the CG only took their medication. The study's three-month duration comprised the following important criteria: height, weight, BMI, blood pressure, FBS, and HbA1c. The EG and CG of weight, height, and BMI distributions before and after three months of therapy. With pre and post-test values of 67.82 ± 12.45 & 62.01 ± 12.03 , 27.24 ± 2.41 & 22.23 ± 2.32 in the EG, correspondingly, weight and BMI stood out among the three main variables examined.

4.1. Influence of yogasanas on BP

Figure 2 and Table 1 compares the EG and CGs anthropometric and biochemical characteristics at pre-and post-test. While CG did not significantly change from pre-test, and there was no difference between the EG and CG before and after the intervention, EG showed a substantial decrease in weight ($p = 0.004$) and BMI ($p = 0.008$).

Table 1 illustrates the characteristics of the yoga and non-yoga groups. The DBP ($p < 0.05$) and SBP ($p < 0.01$) values were significantly improved in EG. CG's blood pressure did not change after the intervention. The EG and CG systolic blood pressures at pre-and post-test differed significantly.

Table 1 – Characteristics of the Yoga and Non-Yoga Groups

Variables	CG (n = 150)	EG (n = 150)	p value
M: F	31:49	30:50	–
Age (years)	52.8 ± 7.0	50.8 ± 8.3	0.022
SBP (mm/Hg)	121.3 ± 13.1	124.4 ± 13.6	0.045
DBP (mm/Hg)	76.7 ± 6.8	77 ± 6.9	0.691

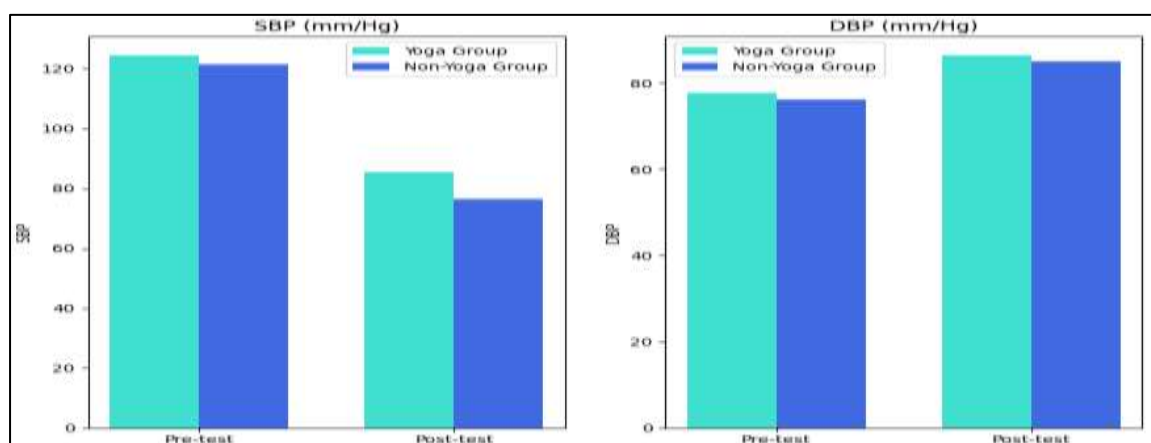


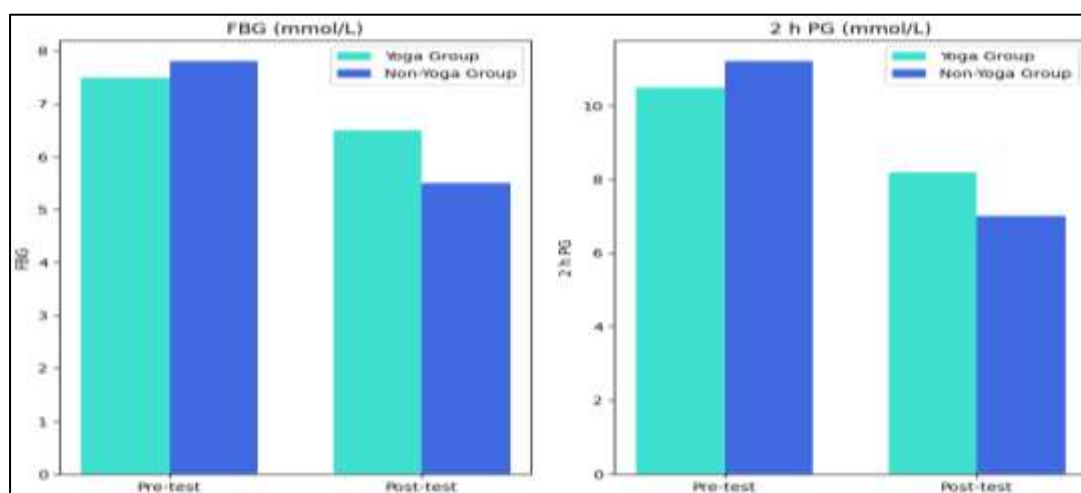
Figure 2. Analysis of BP between pre- and post-test among yoga and non-yoga groups

4.2. Influence of yogasanas on glycaemic control

At pre-test, the HbA1c levels in both groups were comparable. Following the intervention, the yoga group's HbA1c was found to have significantly decreased (pre-test vs. post-test; 7.5(0.5) vs. 7.2(0.9), $p < 0.001$). Figure 3 and Table 2 shows the glycaemic control of the yoga and non-yoga groups. EGs' fasting plasma glucose (mg/dl) levels were significantly lower (pre-test vs. post-test: 140(37) vs. 128(36), $p < 0.01$), and postprandial glucose (mg/dl) levels were significantly lower (pre-test vs. post-test: 215(64) vs. 197.5(67.8), $p < 0.001$). The fasting and postprandial glucose levels in CG did not differ significantly.

Table 2 – Glycemic Control of the Yoga and the Non-Yoga Groups.

Variables	Groups	Pre-test	Post-test	P-value
FBG (mg·dL ⁻¹)	Yoga	141.85 ± 10.10	144.75 ± 11.51	0.058
	Non-yoga	145.75 ± 12.93	140.85 ± 12.49	<0.01
HbA1c (mg%)	Yoga	6.25 ± 1.24	6.31 ± 1.30	0.444
	Non-yoga	6.29 ± 1.30	6.10 ± 1.31	<0.05
PBG	Yoga	6.25 ± 1.24	6.31 ± 1.30	0.444
	Non-yoga	6.29 ± 1.30	6.10 ± 1.31	<0.05



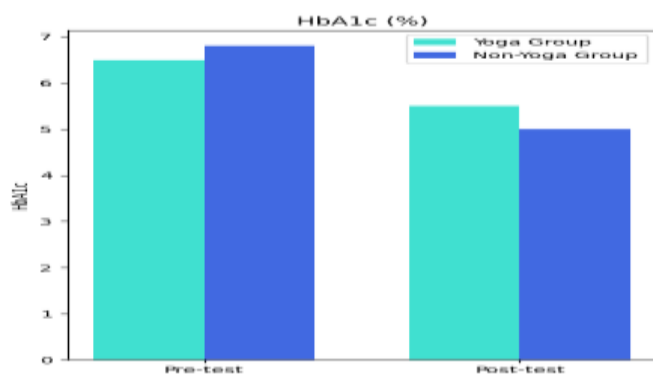


Figure 3. Glycemic Control of Yoga and Non-Yoga Groups

4.3. Influence of yogasanas on sleep quality

Four of the seven components examined by PSQI, considerably improved in EG, and CG use of sleep aids was much lower than in EG. Figure 4 and Table 3 shows the comparative analysis of sleep quality among the EG and CG at pre- and post-test. Sleep length and sleep latency varied significantly between the EG and CG. While individuals who performed yogasanas demonstrated a significant enhancement in their overall sleep quality, subjects in EG did not show any improvement. Overall score (pre-test vs. post-test: 3.9 ± 3.2 ; 3.4 ± 2.7 ; $p = 0.005$ vs 5.4 ± 3.7 ; 5.4 ± 2.7 ; $p = 0.2$; pre-test vs. post-test).

Table 3 – Comparative analysis of sleep quality among the EG and CG at Pre- and Post-test

Variables	EG		CG		p-value	
					Pre-test	Post-test
					EG vs.CG	EG vs. CG
	Pre-test	Post-test	Pre-test	Post-test		
Sleep Latency Period	0.70 ± 0.7	0.89 ± 0.9	0.83 ± 0.8	$0.65 \pm 0.7^*$	0.183	0.153
Sleep Quality	0.84 ± 0.9	0.97 ± 0.9	0.97 ± 0.9	$0.84 \pm 0.6^{**}$	0.137	<0.002
Habitual Sleep Effectiveness	0.63 ± 1.1	0.97 ± 1.0	0.89 ± 0.7	0.89 ± 0.9	0.149	0.056
Sleep Duration	0.89 ± 0.7	0.96 ± 0.9	0.62 ± 0.6	0.53 ± 0.9	0.827	0.432
Usage of Sleep Medication	0.67 ± 1.0	0.87 ± 1.2	0.72 ± 0.5	$0.62 \pm 0.9^*$	0.435	0.089
Sleep Disturbance	0.38 ± 0.8	0.65 ± 0.7	0.63 ± 0.3	$0.29 \pm 0.5^{**}$	0.312	0.004
Day Time Dysfunction	0.07 ± 0.5	0.32 ± 0.6	0.24 ± 0.4	0.20 ± 0.4	0.984	0.847
Overall Score	6.4 ± 3.7	6.3 ± 3.7	6.0 ± 1.3	$5.4 \pm 2.7^{**}$	0.256	0.006

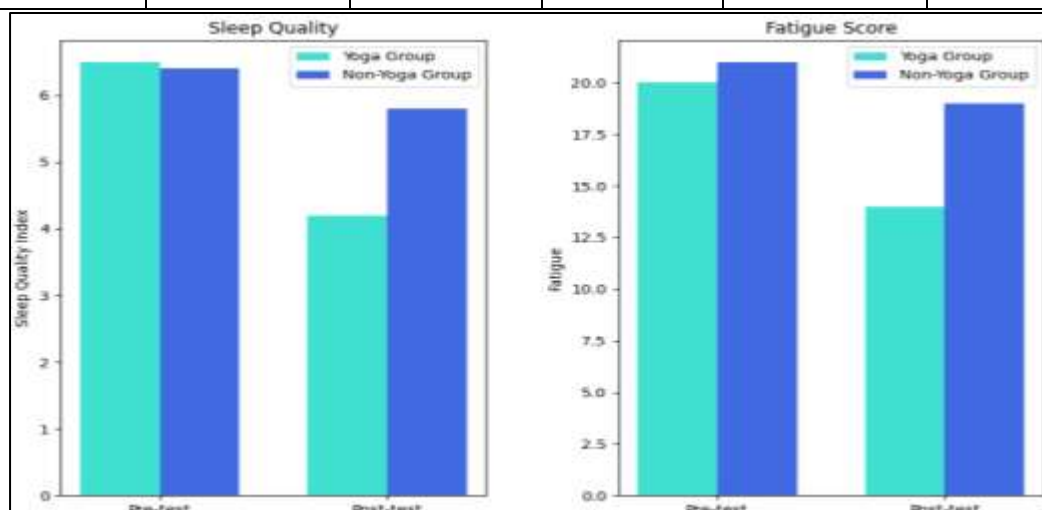


Figure 4. Sleep Quality Index of Yoga and Non-Yoga Groups

5. CONCLUSION

In this study, we investigate the influence of regular yoga practice on sleep quality, blood pressure, and glycemic control in T2DM. To achieve the purpose of this study, two groups were randomly assigned to participants with T2DM who were seen at a diabetic tertiary care centre. While the Control group (non-Yoga) (n = 120) was encouraged not to engage in any activities, EG (Yoga) (n = 120) received training and instruction to perform yogasanas for 60 minutes four days during a 12-week period. For twelve weeks, the EGs will receive their corresponding instruction for an hour every day, three days a week. Glycemic control, blood pressure, and sleep quality were measured both before and after the experimental test. Blood glucose, HbA1c, SQI, actigraphy, and systolic/diastolic blood pressure were all significantly lower in the yoga group than in the non-yoga group. Blood pressure, glycemic control, and sleep quality all significantly improved in those who practiced yogasanas. Subjects with T2DM who regularly performed Yogasanas experienced improvements in glycaemic control, sleep quality, oxidative stress, blood pressure and inflammatory response. Therefore, Yogasanas can be used as an effective treatment for controlling T2DM.

The study recommends that practicing yoga might assist in managing and preventing diabetes, proposing it could be an effective adjuvant treatment to T2DM. Both patients report feeling healthy and experiencing no side effects from the yoga lifestyle. We can conclude that yoga can be used to increase biochemical markers in place of medicinal therapy. In addition, yoga therapy improves the health of diabetics by lowering insulin dosages, preserving mental and physical concentration, and preventing problems. As a result, it is justified to incorporate yoga into the prevention and maintenance of T2DM, and it is highly recommended as a major treatment for the disease. In the future, the research should focus on comparing the efficacy of yoga under supervised and unsupervised programs, examining minute changes in insulin and medication ratings, extending the duration of the intervention, and taking it into account when designing epidemiologic studies.

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