

A Comparative Study of the Effect of Yoga versus Aerobic Exercise on Blood Glucose Level and Quality of Life in Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Background: Type 2 Diabetes Mellitus is characterized by a combination of peripheral insulin resistance and inadequate insulin secretion by pancreatic beta cells. This build-up of glucose in the blood over a prolonged period of time may lead to serious, long-term complications which can affect the quality of life. In subjects with type 2 Diabetes Mellitus, physical training has shown to have a positive increase in insulin secretion. Effect of Yoga therapy on blood glucose level in diabetic patients has also been extensively studied. However, no study has been done till date, comparing the effects of yoga and aerobic exercises on blood glucose levels & quality of life in type 2 DM patients.

Objective: To compare the effects of Yoga & aerobic exercise in the form of walking on fasting blood glucose level & quality of life in type 2 Diabetes Mellitus.

Materials & Methods: A convenience sample of 40 type 2 Diabetes Mellitus subjects participated in this study. Fasting blood glucose level & quality of life score was measured on day 1 and day 30 in group A which performed yogasanas under supervision 5 times a week for 4 weeks. The scores were compared with group B which performed walking for 5 days a week for 4 weeks.

Results: A statistically significant reduction in fasting blood glucose level as well as significant improvement in the Quality Of Life score was observed after 4 weeks of training in both the groups. However, a statistically non-significant change was seen in both fasting blood glucose level and Quality Of Life score on comparison between groups A & B.

Conclusion: The above study shows that Yoga and Aerobic Exercise, in the form of walking, are equally effective in reducing blood glucose levels and improving the quality of life in subjects with Type 2 Diabetes Mellitus.

Key words: Aerobic exercise, Blood glucose level, Type 2 diabetes, Ferrans and Powers Quality of Life Index, Yogasanas.

INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic diseases characterized by high blood sugar levels over a prolonged period that further produces symptoms like

frequent urination, increased thirst and increased hunger. [1]

India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the “diabetes capital of the world”. According

to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India currently around 40.9 million is expected to rise to 69.9 million by 2025 unless urgent preventive steps are taken. The “Asian Indian Phenotype” refers to certain unique clinical and biochemical abnormalities in Indians that include increased insulin resistance and greater abdominal adiposity i.e., higher waist circumference despite lower body mass index. This phenotype makes Asian Indians more prone to diabetes and premature coronary artery disease. Although a part of this is due to genetic factors, the primary driver of the epidemic of diabetes is the rapid epidemiological transition associated with changes in dietary patterns and decreased physical activity as is evident from the higher prevalence of diabetes in the urban population. [2]

Diabetes is characteristically of two types. Type 1 Diabetes Mellitus, is due to the body's failure to produce sufficient insulin due to an autoimmune condition that causes destruction of the insulin producing beta cells in the pancreas. Type 2 Diabetes Mellitus is characterized by a combination of peripheral insulin resistance and inadequate insulin secretion by pancreatic beta cells. Insulin resistance, which has been attributed to elevated levels of free fatty acids and pro-inflammatory cytokines in plasma, leads to decreased glucose transport into muscle cells, elevated hepatic glucose production, and increased breakdown of fat. [3]

When there is a build-up of glucose in the blood over a prolonged period of time instead of being absorbed by the cells, it may lead to acute complications such as Diabetic Ketoacidosis and serious, long-term complications such as Coronary Artery Disease, Neuropathy, and Nephropathy, if left untreated. [4] Therefore, the topic of Diabetes Mellitus was chosen as it has a wide prevalence and an array of complications that can be prevented if appropriate measures are taken.

Diabetes Mellitus is most commonly assessed using the Fasting Plasma Glucose test that tests the patients fasting blood glucose levels. The patient must not have had anything to eat for at least 8 hours before the test. Hence the test is typically conducted in the morning, before breakfast. The test is positive if the fasting blood glucose is greater than or equal to 126 mg/dl. [5]

Quality of life may be thought of as a multidimensional construct incorporating an individual's subjective perception of physical, emotional, and social wellbeing, including both a cognitive component and an emotional component. Quality-of-life issues are crucially important, because they may powerfully predict an individual's capacity to manage his disease and maintain long-term health and wellbeing. In diabetes, poor quality of life leads to diminished self-care, which in turn leads to worsened glycemic control, increased risks for complications, and exacerbation of poor quality of life in both the short run and the long run. [6]

Quality of life can be assessed using the Ferrans and Powers Quality of Life Index (Diabetes Version III). The Quality of Life Index measures Satisfaction and Importance in various domains of life such as health and functioning domain, psychological/ spiritual domain, economic domain and family. The scores reflect the importance and satisfaction with the aspects of life valued by the individual. Hagell and Westergren, in 2006, conducted an evaluation on the Ferrans and Powers Quality of Life index and stated it valid and reliable. [7]

Management of Type 2 Diabetes Mellitus includes Medication or insulin therapy, regular exercise and healthy eating. Medications are chosen based on factors such as blood glucose levels and the health problems faced by the patient. [8]

The American College of Sports Medicine defines Aerobic exercise as any exercise that is rhythmic, continually maintained and involves large muscle

groups. According to the American Diabetes Association, moderate intensity aerobic exercise plays a key role in managing Diabetes. In subjects with type 2 Diabetes Mellitus, physical training may lead to an increase in insulin secretion results perhaps due to accompanying sensitization of the autonomic nervous system. [9] Previous studies have reported that exercise leads to improvements in metabolic control, measured by HbA_{1c}, blood glucose, or insulin sensitivity. [10] A definitive study to this to date, is a randomized, controlled trial conducted on 251 Type 2DM patients that reported improvements ranging from -0.38 to -0.97 percentage points in HbA_{1c} from exercise training that ranged from ≈135 to 270 minutes of exercise per week for 6 months. [11]

Walking was chosen as the mode of aerobic exercise in the study since it is widely accepted, easy to perform and one of the most commonly used forms of exercise. In a study, 39 participating Type 2 Diabetics walked for half an hour everyday for 8 weeks and it showed that post-walk glycemic levels were reduced by 2.2 mmol/l (SD 1.5). [12] A. T. Høstmark, G. S. Ekeland, A. C. et al in 2006, explained that postprandial light physical activity blunts the blood glucose increase in subjects with Type 2 Diabetes Mellitus. [13]

Yoga, from the Sanskrit word *yuj* is a method of discipline that involves eight limbs, namely; the Yamas (restraints), Niyamas (observances), Asanas (postures), Pranayama (breathing), Pratyahara (withdrawal of senses), Dharana (concentration), Dhyani (meditation), and Samadhi (absorption). Most people practicing yoga today are engaged in Asana, which is a program of physical postures designed to purify the body and provide physical strength and stamina.

Yoga is known to have various effects such as relaxation, improved flexibility, increased strength, improved posture, and improved breathing pattern. The various postures and positions of the asanas are said to stimulate the pancreas by

directly stimulating pancreatic cells, thus increasing insulin secretion and regulation and reducing blood glucose levels. [14] A study conducted to examine the impact of 8 weeks of yoga training on blood glucose levels in patients with Type 2 Diabetes Mellitus indicated a significant difference in the changed levels of blood glucose between the control and experimental groups. [15] In comparison with standard care alone, yoga resulted in significant reduction in BMI and an improvement in glycemic control. [16]

As per our knowledge, no study has been done till date, comparing the effects of yoga and walking in type 2 DM patients.

MATERIALS AND METHODS

40 subjects having type 2 Diabetes Mellitus were included in this prospective, randomized clinical trial, based on the inclusion and exclusion criteria.

Inclusion criteria: Patients who have had Type 2 Diabetes Mellitus for a time period between 5 and 10 years and who are currently on oral hypoglycemic drugs

Exclusion criteria

1. Patients with neurological symptoms or any other complications due to Diabetes Mellitus
2. Patients on insulin therapy
3. Patients previously performing yoga or walking or both

Patients unwilling to take part in the study

Each of them was explained about the study and its benefits and written consent was obtained from every patient. Demographic data like age, gender and BMI were checked and documented. Fasting blood glucose level (FBS) was assessed in all the patients prior to intervention. Quality of life of the patient (QOL) was also assessed using the Ferrans and Powers Quality of Life Index (Diabetes Version III) and the total score of all domains was obtained. The subjects were then randomly divided in two groups, group A for Yoga and group B for Walking. Subjects from group A were taught 15 yoga asanas in standing, sitting and lying positions and

were asked to perform the asanas 5 times a week for 4 weeks. The asanas were Tadasana, Veerbhadrāsana, Trikonāsana, Sukhasana, Padmasana, Yogamudrasana, Vakrasana, Gomukhasana, Paschimottāsana, Dhanurasana, Naukasana, Bhujangāsana, Pawanmuktāsana, Sethubandhasana and Shavasana. Breathing exercises and meditation sessions were conducted in first 10 minutes followed by performance of the above asanas in the next 35 minutes. 2 repetitions of each asana were given in the sequence mentioned above. The session ended with Shavasana. A 30 second rest pause was provided between each asana. A demonstration was given to the subjects prior to the intervention. Subjects from group B were asked to walk for 45 minutes 5 times a week for 4 weeks. The subjects were asked to walk at a brisk pace and cover as much distance as possible. At the end of 4 weeks, all outcome measures were checked again and the data was statistically analyzed.

Statistical analysis

In the present study, the effects of 4 weeks of Yoga and walking on blood glucose levels and quality of life were

compared in subjects with Type 2 DM using GraphPadInstat. The data was compared between the two groups prior to the intervention to assess the homogeneity of the samples. Post intervention, assessment was done within the groups and between the groups. To determine the statistical significance, p value was set as $p < 0.05$. All the data is mentioned in the form of 'Mean \pm Standard deviation'.

Table 1: Comparison of parameters pre-intervention between Yoga and Aerobic Exercise groups

	Group A	Group B	p value
Age group (years)	57 \pm 9.2	55.8 \pm 6.4	p= 0.635
Gender	Males: 8 Females: 12	Males: 14 Females: 6	
BMI (kg/m ²)	24.2 \pm 2.4	24.8 \pm 4.8	p= 0.581
FBS (mmol/L)	93.4 \pm 17.7	95.7 \pm 18.3	p = 0.689
QOL score	383.1 \pm 7.9	382.4 \pm 4	p = 0.794

Inference: On comparison of the data pre-intervention, the p values yielded were statistically non-significant. This suggested that the data was homogenous in distribution.

The above table suggests that both Yoga and aerobic exercise are effective in reducing blood glucose levels in patients with Type 2 Diabetes Mellitus

Table 2: Comparison of Fasting Blood Glucose levels (FBS) in both Groups A & B pre and post intervention

Parameters	Group A		p value	Group B		p value
	Pre	Post		Pre	Post	
FBS level (mmol/ L)	93.4 \pm 17.7	92.1 \pm 17.6	0.0001	95.7 \pm 18.3	94 \pm 17.4	0.0003

Table 3: Comparison of Quality of Life (QOL) score in both Groups A & B pre and post intervention.

Parameters	Group A		p value	Group B		p value
	Pre	Post		Pre	Post	
QOL score	383.1 \pm 7.9	387.1 \pm 7.5	0.0008	382.4 \pm 4	387.8 \pm 8.2	0.0001

Table 4: Comparison of Fasting Blood Glucose levels (FBS) and Quality of Life (QOL) post intervention between Groups A & B.

	Group A	Group B	p value
FBS level (mmol/L)	92.1 \pm 17.6	94 \pm 17.4	p= 0.7432 (Not significant)
QOL score	387.1 \pm 7.5	387.8 \pm 8.2	p = 0.5765 (Not significant)

The above table suggests that both Yoga and aerobic exercise are effective in improving the QOL in patients with Type 2 Diabetes Mellitus

On comparison of Fasting Blood Glucose levels & Quality Of Life post intervention between group A and group B,

the p value obtained was statistically non-significant. This suggests that both Yoga and Aerobic exercise in the form of walking are equally effective in reducing blood glucose levels & improving the Quality Of Life in patients with Type II Diabetes Mellitus

DISCUSSION

Type 2 Diabetes Mellitus is characterized by a combination of peripheral insulin resistance and inadequate insulin secretion by pancreatic beta cells.

Insulin resistance, which has been attributed to elevated levels of free fatty acids and pro-inflammatory cytokines in plasma, leads to decreased glucose transport into muscle cells, elevated hepatic glucose production, and increased breakdown of fat. [3]

Management of Type 2 Diabetes Mellitus includes medication or insulin therapy, regular exercise and healthy eating. Medications are chosen based on factors such as blood glucose levels and the health problems faced by the patient. Common medications include Metformin, which improves the sensitivity of the body tissues to insulin and lowers glucose production in the liver. Sulfonylureas are also used and these help the body secrete more insulin. Meglitinides work similar to sulfonylureas except that they are faster acting and do not stay active in the body for long. [8]

The American College of Sports Medicine defines Aerobic exercise as any exercise that is rhythmic, continually maintained and involves large muscle groups. According to the American Diabetes Association, moderate intensity aerobic exercise plays a key role in managing Diabetes. Recent studies have shown that exercise training is recommended for patients with Type 2 Diabetes Mellitus as it may have beneficial effects on metabolic risk factors such as improving glycemic control along with reducing the risk of diabetic complications. [17] Walking was chosen as the mode of aerobic exercise in the study since it is widely accepted, easy to perform and one of the most commonly used forms of exercise.

Post Aerobic exercise, peripheral glucose uptake exceeds hepatic glucose production thus reducing blood glucose levels. Also, glucose is transported to skeletal muscles via a transporter enzyme GLUT-4. Exercise increases the translocation of GLUT-4 to skeletal muscle membrane and improves the glucose uptake and hence reduces blood glucose levels. [18]

Boule' et al (2001) undertook a systematic review on the effects of structured exercise interventions in clinical

trials of 8 weeks duration on HbA1c and body mass in people with type 2 Diabetes. Post-intervention HbA1c was significantly lower in exercise than control groups; $p < 0.001$. Another study on effects of physical training on insulin secretion and effectiveness and on glucose metabolism in Type 2 Diabetes Mellitus shows that both insulin secretion and effectiveness were altered by physical training in different ways in different clinical entities. In insulin resistant conditions with high insulin secretion, increased peripheral insulin sensitivity was followed by decreased insulin secretion. In Type 2 Diabetes with low insulin secretion, an increase in insulin secretion is seen as a result of physical training perhaps due to accompanying sensitization of the autonomic nervous system. Peripheral insulin concentrations are not altered; suggesting that the extra insulin produced is captured by the liver. [9] Valerie Myers, Megan McVay, et al performed a study in 2013 on Exercise Training and Quality of Life in individuals with Type 2 Diabetes Mellitus and the results showed that exercise training interventions improved physical health QOL in individuals with type 2 diabetes mellitus regardless of training modality (aerobic, resistance, or combined). [19]

Yoga, the traditional exercise form, offers a largely unexplored, widely available resource for the management of stress-related ailments. There is evidence that Yoga can benefit patients with Type 2 Diabetes Mellitus. A randomized, controlled trial of Yoga for patients with Type 2 Diabetes Mellitus showed that both Fasting Blood Glucose and Hb1Ac improved significantly along with patients reporting that they felt better, less anxious and more in control of themselves. [20] Surwit and Feingloss in 1992 reported that Yoga training leads to improved glucose tolerance in patients with Type 2 Diabetes Mellitus without affecting insulin sensitivity or glucose-stimulated insulin secretory activity. This could be mediated by a

decrease in sympathetic and adrenal cortical activity.

There is growing evidence concerning the potent effect of psychosocial factors on physical health outcomes. People with diabetes often feel challenged by their disease and its day to day management demands. This it can lead to stress. The psychosocial toll of living with diabetes can often affect self-care behavior, long-term glycemic control, Quality of Life and risk of developing long-term complications. A study assessing the effect of a comprehensive yogic program on glycemic control and quality of life in patients with Type 2 Diabetes Mellitus showed a trend toward improvement in glycemic control along with a significant improvement in physical, psychological and social domains of quality of life. Among several hypotheses for the biological mechanisms that link the benefits of yoga to diabetes management, one hypothesis points to the role of stress and anxiety, which in turn affects behavior. Yoga is practiced worldwide for its health benefits, including physical fitness, relaxation and awareness of self. It is based on the principle that the mind and body are intimately related. The physical postures and breathing exercises improve muscle strength, flexibility, blood circulation and oxygen uptake which in turn have been found to be useful in relieving stress, anxiety and depression and improving the antioxidant and immune defenses of the body. ^[21] This can explain the improvement in Quality of Life with Yoga.

The present study shows that both Yoga and Aerobic exercise, in the form of walking, are equally effective in reducing blood glucose levels and improving the quality of life in subjects with Type 2 Diabetes Mellitus. Walking is one of the most common forms of exercise that is easy, widely accepted and does not require any training, monitoring or equipment. Patients have the freedom of performing it at their convenience and it is not limited by the patient's fitness level. Although yoga is an exercise form that has multi-dimensional

effects, it requires special training, a fixed protocol and constant monitoring for fear of being injured during performance of certain asanas.

LIMITATIONS AND SUGGESTIONS

1. The above study has a small sample size. A larger sample size may help in studying greater variations in the study population and hence will show us the variations in the results, if any.
2. Fasting Blood Glucose has been used as an outcome measure for the above study. This outcome measure can be influenced by various other factors, for e.g. Diet and lifestyle. Hb1Ac or Glycosylated Hemoglobin is a form of hemoglobin that is measured primarily to identify the average plasma glucose concentration over prolonged periods of time. As the average amount of plasma glucose increases, the fraction of glycosylated hemoglobin increases in a predictable way. This serves as a marker for average blood glucose levels over the previous 3 months as this is the half-life of red blood cells. Hence, Hb1Ac could be considered as a more reliable outcome measure. The Hb1Ac has several advantages to the Fasting Blood Glucose test, including greater convenience since fasting not required, possibly greater pre-analytical stability, and less day-to-day perturbations during stress and illness.
3. No follow up was done on the subjects who were a part of the study. A follow up will help us gauge the patient adherence to the intervention along with giving us an idea of how long the effect of the intervention lasts.
4. Patient preference to treatment method can be checked. Since both treatment methods are equally effective, it would be beneficial to know the preference of the patient to both treatment methods to assess the comfort of the patient to the treatment methods and its usability. This can improve the patient adherence to the treatment method.

CONCLUSION

The above study shows that Yoga and Aerobic Exercise, in the form of walking, are equally effective in reducing blood glucose levels and improving the quality of life in subjects with Type 2 Diabetes Mellitus. Hence either Walking or Yoga can be used as a successful non-pharmacological intervention program in patients with Type 2 Diabetes Mellitus.

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