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EFFECT OF YOGIC INTERVENTION ON WAIST CIRCUMFERENCE AND GLYCEMIC CONTROL AMONG PREDIABETIC YOUNG ADULTS: A RANDOMIZED CONTROLLED STUDY

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ABSTRACT

Yoga therapy is well known therapy for prediabetics, (Prevention of Type- 2 Diabetes Mellitus ie. T 2DM)) which is safe, effective, and easy-to-learn. It can be practiced by adolescents, young adults, elderly people and also people with disabilities.

Aim: Effect of 6 months of yoga therapy on glycemic control among abdominal obesity diagnosed with prediabetic young adults: A randomized controlled study.

Settings and Design: The study is conducted at Swasthya Kalyan Group of InstitutionsS, Jaipur for 6 months.

Materials and Methods: A total of 105 students, diagnosed as abdominal obesity, were selected and registered for the study from Swasthya Kalyan Group of Institutions, Jaipur as participants who were divided into interventional and control groups by computer-generated, randomized number sequence method. The yogic practice was advised to 52 study participants, and the remaining 53 participants were advised not to do any exercise or yoga for 6 months. The glycemic outcome was evaluated by HbA1c which was examined at baseline, and at the end of 6 months.

Statistical Analysis Used: Paired t-test. Generalized estimating equations models were performed on the glycemic control variables to assess the differences between the intervention and control groups.

Results: The post-test analysis of 105 abdominal obesity diagnosed with pre-diabetic adults's data inferred that the Intervention group has shown statistically significant ($P < 0.05$) effect on reducing HbA1C. However, no statistically significant difference ($P > 0.05$) was observed when the Intervention group was compared with the control group on glycemic control (reducing HbA1c).

Actually, yoga is an effective alternative method, hence people with morbidities or who are unable to go for exercise can practice yoga at home which will help them to prevent the level of HbA1c and risk of Type II diabetes.

Keywords: Diabetes Mellitus, HbA1c, Yoga, Obesity, Adults

1. INTRODUCTION

Prediabetes is a metabolic condition where blood sugar levels are elevated but not yet high enough to be classified as Type 2 Diabetes Mellitus (T2DM). Prediabetes increases the risk of developing T2DM, cardiovascular diseases, and other metabolic disorders. One significant indicator of prediabetes, especially in young adults, is an enlarged waist-to-hip ratio (WHR), which refers to excess fat accumulation around the abdominal area.[1] This study explores the relationship between an enlarged WHR in pre-diabetic young adults, associated risk factors, and ways to prevent the progression to T2DM.

Waist-to-hip ratio (WHR) is a marker of abdominal obesity, calculated by dividing the circumference of the waist by that of the hips. A high WHR is associated with visceral fat accumulation, which is more metabolically active and detrimental than subcutaneous fat. Numerous studies have linked an enlarged WHR to insulin resistance, chronic inflammation, and dyslipidemia, all of which are risk factors for prediabetes and eventual T2DM. [2] Young adults with an enlarged WHR are more likely to experience impaired glucose tolerance due to insulin resistance, which reduces the efficiency of glucose uptake by cells, leading to elevated blood sugar levels.

Several risk factors contribute to the development of prediabetes in young adults with an enlarged WHR:

1) **Obesity and Sedentary Lifestyle:** Excess body fat, particularly visceral fat in the abdominal region, is a strong predictor of insulin resistance. Young adults who lead sedentary lifestyles and have poor dietary habits, such as consuming high-calorie, low- nutrient foods, are at greater risk of prediabetes.
2) **Genetics and Family History:** Individuals with a family history of diabetes are more prone to developing prediabetes. Genetic predisposition, combined with environmental factors like physical inactivity, exacerbates the risk of T2DM in young adults.
3) **Insulin Resistance:** A key mechanism in prediabetes is insulin resistance, where the body's cells become less responsive to insulin, leading to higher blood glucose levels. Enlarged WHR is often a sign of increased visceral fat, which is linked to higher insulin resistance.
4) **Dyslipidemia and Hypertension:** Young adults with enlarged WHR are more likely to exhibit dyslipidemia (abnormal lipid levels), particularly elevated triglycerides and low HDL cholesterol, both of which contribute to cardiovascular risk and impaired glucose regulation. Similarly, hypertension is more prevalent in this group, further increasing their risk for diabetes.
5) **Chronic Inflammation:** Abdominal fat secretes pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), which promote insulin resistance. Chronic low-grade inflammation is a hallmark of obesity-related prediabetes.

The term diabetes mellitus (DM) refers to a group of related metabolic disorders that are characterized by the same hyperglycemia phenotype. It results from insufficiencies in the production and activity of insulin. Long-lasting harm to several organs, including the heart and blood arteries, is one of the major complications of diabetes mellitus. The development of multiple distinct types of diabetes mellitus is caused by a complicated interplay between inherited and environmental variables. Depending on the cause of the diabetes, hyperglycemia is caused by decreased insulin secretion, decreased glucose intake, and increased glucose production.[3]

There are two forms of diabetes: type-1 and type-2, which include gestational diabetes, newborn diabetes, maturity-onset diabetes of the young (MODY), and diabetes brought on by endocrinopathies, medications, and other causes. Type 1 diabetes (T1DM) and type 2 diabetes (T2DM) are the two different forms of the disease, and they are both brought on by ineffective insulin secretion or action. While T1DM is more common in children or teens, type 2 diabetes (T2DM) is more common in middle-aged people who have persistent hyperglycemia as a result of lifestyle and dietary choices. Because of the significant differences in their pathophysiologies, T1DM and T2DM each have their own unique presentation, aetiology, and management approach.[4] Though the purpose of the current study is to determine how yoga affects glycaemic management in T2DM patients, the researchers focus is solely on T2DM patients.

T2DM accounts for 90–95% of DM cases.[5] Hyperglycemia caused by IR and/or insufficient insulin synthesis is a hallmark of type 2 diabetes (T2DM), a metabolic and endocrine condition.[6]

The rate at which DM is becoming more commonplace worldwide is startling. [4] It is noteworthy that the incidence is rising on all six of the inhabited continents of the planet.[7] From a modest geriatric ailment to one of the main causes of morbidity and mortality in young and middle-aged adults, diabetes mellitus has changed over the last thirty years.

Despite an increase in the prevalence of T1DM, diabetes is mostly caused by type 2 diabetes, which accounts for 90% of all cases of the disease.[8]

There were an estimated 171 million DM patients worldwide in 2000; by 2030, this number is expected to climb to 366 million, and the share of DM patients living in developing countries is expected to increase from 74% in 2000 to 81% in 2030.[9,10] Asian and Indian populations are widely dispersed over Europe, Africa, and the Middle East. The prevalence of DM in these areas is significantly higher than in the indigenous populations of those nations.[10–12]

Many people in South Asian nations including Bangladesh, Pakistan, Sri Lanka, and Nepal suffer from diabetes mellitus.[12–13]

Despite having a low body mass index (BMI), Asian Indians have a specific phenotype that is characterised by increased intra-abdominal fat and IR (IR), which puts them at risk for T2DM and early coronary heart disease (CHD). Asian Indians make up about 17% of the world's population. [15, 14]

India is among the epicentres of the global epidemic, with 69 million people living with diabetes in 2015—the second-highest number in the world. [15, 17]

Diabetes interferes with the metabolism of water, electrolytes, lipids, proteins, and carbs. Sustaining these metabolic disturbances results in long-term, permanent alterations to the morphological and functional composition of the body's cells, giving rise to "diabetic complications" that primarily affect the kidney, nerve, eye, and cardiovascular systems. [18]

Slow and non-enzymatic glycosylation of haemoglobin results in the formation of glycosylated haemoglobin (HbA1c), a measure that indicates glucose directive in diabetes. Additionally, it shows that diabetics can control their blood sugar levels and is highly associated with the risk of developing diabetes complications. [18–19] Elevated glucose levels, as determined by HbA1c, are associated with a higher risk of health issues.18,20 in line with type-2 diabetes epidemiology studies. The American Diabetes Association (ADA) and the American Association of Clinical Endocrinologists recommend a target HbA1c of 6.5% or 7.0%, respectively, for patients with a short history of diabetes mellitus, a prolonged life expectancy, and a low risk of hypoglycemia. [19-21]

Although yoga has been shown to have numerous advantages for glycaemic control as well as general welfare, little study has been done on its potential to enhance quality of life by reducing stress, anxiety, and depression as well as encouraging people to lead active lifestyles. Prior studies have underscored the importance of conducting additional study to have a deeper comprehension of the potential effects of yoga on blood glucose levels. In light of these details, the current study set out to ascertain how well yoga affected the lipid profile, BMI, and glycaemic control in T2DM patients.

2. RESEARCH REVIEW

The global prevalence of prediabetes and Type II Diabetes Mellitus (T2DM) is rising, emphasizing the need for effective interventions. Yoga, an ancient mind-body practice, has gained increasing attention for its potential role in managing blood glucose levels and preventing T2DM, particularly among individuals with prediabetes. This review examines the existing body of research on the relationship between yoga and glycemic regulation in abdominal obesity diagnosed prediabetic adults to understand its potential role in diabetes prevention.

2.1. YOGA AND INSULIN SENSITIVITY

Several studies have explored the impact of yoga on insulin sensitivity, a critical factor in the regulation of blood glucose levels. Insulin resistance, which is prevalent among individuals with prediabetes, impairs the body's ability to utilize glucose effectively. Yoga's combination of physical postures (asanas), breathing exercises (pranayama), and relaxation techniques has been shown to improve insulin sensitivity. A study by Innes et al. (2005) [22] demonstrated that yoga improved fasting blood glucose levels and insulin sensitivity in adults at risk of T2DM, suggesting its potential role in preventing the progression to diabetes.

2.2. REDUCTION IN FASTING BLOOD GLUCOSE AND HBA1C LEVELS

Fasting blood glucose and glycated hemoglobin (HbA1c) are key markers of glycemic control. Research suggests that regular yoga practice can significantly lower fasting blood glucose levels in individuals with prediabetes. A randomized controlled trial by McDermott et al. (2014) found that a 12-week yoga intervention led to significant reductions in fasting glucose levels among participants with prediabetes. Similarly, a study by Kumar et al. (2018) [23] reported decreases in HbA1c levels in prediabetic individuals following consistent yoga practice, further highlighting the potential of yoga to enhance long-term glycemic control.

2.3. ROLE OF STRESS REDUCTION IN GLYCEMIC REGULATION

Stress is a well-established contributor to insulin resistance and poor glycemic control, primarily through the activation of the hypothalamic-pituitary-adrenal (HPA) axis and the release of cortisol, a hormone that elevates blood glucose levels. Yoga's emphasis on stress reduction through mindfulness and relaxation has been suggested as a mechanism for improving glycemic regulation. Research by Kiecolt-Glaser et al. (2010) [24] demonstrated that yoga significantly reduced cortisol levels and improved psychological well-being in individuals at risk of T2DM. This reduction in stress and cortisol levels may play a role in improving insulin sensitivity and preventing diabetes.

3. IMPACT OF YOGA ON METABOLIC SYNDROME COMPONENTS

Prediabetes is often associated with other components of metabolic syndrome, such as abdominal obesity, hypertension, and dyslipidemia, all of which increase the risk of T2DM. Yoga has been shown to positively impact these factors. A study by Jyotsna et al. (2012) [25] demonstrated that a 12-week yoga program led to reductions in waist circumference, body mass index (BMI), and blood pressure in abdominal obesity diagnosed prediabetic adults, factors that are strongly associated with improved glycemic regulation. This holistic impact on multiple metabolic parameters further supports yoga's role in preventing the onset of diabetes.

4. YOGA AND WEIGHT MANAGEMENT

Weight management is crucial for glycemic control in prediabetic individuals, as obesity, particularly visceral fat, is a key risk factor for T2DM. Yoga, particularly more dynamic forms such as Vinyasa or Power yoga, has been shown to promote weight loss and fat reduction. A study by Cramer et al. (2016) [26] reported that regular yoga practice led to significant reductions in body fat percentage and improvements in metabolic function in individuals with prediabetes. Improved weight management directly correlates with better insulin sensitivity and glycemic regulation, thereby reducing the risk of developing diabetes.

5. METHODOLOGY

A randomised controlled trial (RCT) was conducted at the Swasthya Kalyan Group of Institutions, Jaipur. Study participants were randomly sourced who have a hip ratio 1.0 or higher in males and 0.86 or higher in females at the Swasthya Kalyan Group of Institutions, Jaipur. The study was conducted from July 2021 to October 2022. The institutional ethics committee authorized the study and participants provided informed consent prior to enrolment.

The patients who were eligible as per the inclusion criteria were enrolled at the time of data collection. Participants were randomly divided into interventional and control groups by computer-generated, randomized number sequence method. Abdominal obesity prediabetic adult patients of both genders in the age group of 19-24 years, with HbA1c concentrations of 6.5% or more,for at least 6-month duration were included in the study as study participants.

5.1.DATA COLLECTION

During the first visit, socio-demographic details, medication, medical history, any associated health problem, and duration of increased hip ratio were obtained by interviewing the participants. All study subjects were told about the importance of treatment adherence.

5.2. INTERVENTION GROUP

The number of study participants in the yoga intervention group is 52. The intervention consisted of hatha yoga classes with asanas (physical poses), relaxation and pranayama (breathing exercises).

Table 1 Yoga Intervention Plan

Sr. No.	Name of Yoga Practice	Rounds	Duration
1	Tadasana	8 Rounds	2 minutes
2	Vrikshasana	8 Rounds	2 minutes
3	Trikonasana	8 Rounds	2 minute

4	Pada Hastasana	8 Rounds	2 minutes
5	Naukasana	8 Rounds	2 minutes
6	Setu Bandhasana	8 Rounds	2 minutes
7	Ardha Sarvangasana	8 Rounds	2 minutes
8	Matsyasana	10-12 Rounds	4 minutes
9	Paschimottanasana	10-12 Rounds	4 minutes
10	Bhujangasana	8 Rounds	2 minutes
11	Salabhasana	4-5 Rounds	1 minutes
12	Marjaryasana	8 Rounds	2 minutes
13	Adho-mukha Svanasana	1 Rounds	5 minutes
14	Ardha Matsyendrasana	8 Rounds	4 minutes
15	Surya Namaskara	5-10 Rounds	10 minutes
16	Nadi Shodhan	4-6 Rounds	2 minutes
17	Kapalabhati	4-6 Rounds	2 minutes
18	Yoga Nidra	1 Rounds	10 minutes
Total			**50 minutes**

The time and occurrence of classes were roughly 50–60 min, 5 days in a week for 6 months. In the remaining days of the week, study participants were instructed to practice yoga at their home and to maintain a daily log book for seeing the adherence. At the end of 6 months baseline investigations were repeated.

5.3. CONTROL GROUP

The number of study participants in the control group were 53 . The control group instructed not to practice any yoga or other exercise for expenditure of energy such as walking, jogging, cycling, not to take any medication or any alternative medicine to reduce hip ratio or lower down the blood sugar level. One person in the family was identified and was given a checklist to monitor the activities.

5.4. MEASUREMENT

For the estimation of biochemical parameters like Fasting blood sugar (FBS, 100–125 mg/dL) HbA1c (Bio-Rad D-10) about 5 ml of blood was drawn and analyzed by Swasthya Kalyan Group of Institutions, Jaipur. Measurements like height and weight were obtained by trained researchers.

5.5. STATISTICAL ANALYSIS

The data analysis was done to understand the descriptive and inferential statistics in terms of the central tendency of glycemic values and variations in intervention and control groups. The statistical significance from the baseline to 6 months was measured by paired t-test, and variation in the intervention and control groups was calculated by paired t-test. Statistical programming package SPSS version 28.0 was used for calculations. As the data violated the normality and homogeneity of variance, generalized estimating equations (GEE) models were performed instead of mixed-model ANOVA. GEE models were performed on the glycemic control variables to assess the differences between the two groups.

6. RESULTS

The demographic details of the patients are provided in Table 1. Table 1 compares the background characteristics of study participants between the control group and intervention group. No significant association was identified between both the groups. In this study, the participants had a higher level of Hip-ratio (1.0 or higher in males and 0.86 or higher in females) (45.5% in the control group and 54.5% in the intervention group).

Table 2 Mean HbA1c, Standard Deviation and Coefficient of variation within and between the groups

	Within Group (Control)				**Within Group (Intervention)**				**Between Groups**		
	Pre Mean ± SD	Post Mea n ± SD	Difference ± SD	P value	Pre-Mean ±SD	Post Mean ± SD	Difference ± SD	p value	p Value	sd	size (r)

Mean HbA1c	152.21 ± 49.77	153.52 ±49.55	7.69 ± 17.08	p < 0.05	152.91 ± 26.33	128.92 ± 28.16	33.99 ± 28.78	p < 0.001*	p > 0.05	0.61	0.35
Standard Deviati on	41.42 ± 26.96	36.76 ± 26.45	4.57 ± 7.33	p < 0.05*	26.13 ± 9.91	16.34 ±10.18	9.59 ± 7.25	p < 0.001*	P < 0.001**	0.65	0.37
Coefficient of variation	45.47 ± 10.85	44.44 ± 11.70	2.03 ± 3.98	p > 0.05	35.19 ± 6.84	31.86 ± 7.75	4.33 ± 5.09	p < 0.001*	P < 0.001	0.61	0.35

7. COMPARING GLYCEMIC CONTROL (HBA1C) BETWEEN INTERVENTION AND CONTROL GROUP AND BETWEEN THE GROUPS

The mean change in the HbA1c levels at 6 months from the baseline for the yoga intervention and control groups are provided in Table 3. There was a significant decrease of HbA1c in the intervention group after 6 months compared to baseline. However, there was a significant decrease ($p < 0.001$*) However there is no significant decrease in the control group after 6 months compared to baseline ($p < 0.05$) [Table 3].

8. DISCUSSION

There was a statistically significant reduction in the mean glucose levels (HbA1c) in the intervention group (33.99 ± 28.78 mg/dL), with non-significant difference between groups (p

> 0.05).

This study aimed to evaluate the effectiveness of yoga in the prevention of type-2 diabetes mellitus. The objective is to rigorously evaluate a yoga intervention aimed at managing risk

factors of type- 2 diabetes mainly abdominal obesity. Practicing yoga significantly reduced HbA1c blood glucose levels by reducing abdominal circumference. However, control group subjects exhibited no significant differences. A significant decrease in blood glucose levels was observed following 90 days of yoga intervention.

Yoga- a potential solution for diabetes & metabolic syndrome: Thomas et. al. [27] stated, “There is a need for proper randomized controlled interventions with adequate sample size and power with an appropriate duration. The effect of yoga also has to be studied across various ethnic populations and risk categories to identify which pattern of yoga is more beneficial and which disorders benefit best from yogic interventions.” (June 2015). The reduction in metabolic syndrome shown in this study aligns with several prior investigations. Furthermore Sahay et al. have shown a notable reduction in body fat and an increase in lean body mass in individuals with type-2 diabetes following yogic therapies. [28] This study demonstrated a substantial reduction in HbA1c values following 90 days of yoga practices. Monro R et al. reported the value of HbA1c. Mean differences demonstrated that yoga therapies reduced HbA1c levels.

CONFLICT OF INTERESTS

None.

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