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Research Article

A Study of the Role of Yoga Practice in the Management of Metabolic Syndrome

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Abstract

Introduction: Metabolic syndrome (MetS) is a group of metabolic abnormalities including central obesity, hypertension, dyslipidaemia and impaired glucose metabolism, which is associated with an increased risk of type 2 diabetes mellitus and cardiovascular diseases. MetS is a significant public health issue due to the increase in sedentary lifestyle and obesity. Yoga has become a potential non-pharmacological intervention that has the potential to enhance the metabolic health and well-being.

Materials and Methods: This is a hospital-based prospective observational study which was conducted at Muzaffarnagar medical college and hospital in Uttar Pradesh for 18 months. Sixty patients with metabolic syndrome and body mass index (BMI) >25 kg/m² were recruited. The program was a structured yoga program of asana, pranayama, mudras, bandhas and relaxation techniques for about 55 minutes per day for six months. At baseline, 3 and 6 months, anthropometric measurements, fasting blood glucose, lipid profile, blood pressure and World Health Organization Quality of Life-BREF (WHOQOL-BREF) scores were evaluated.

Results: There was significant improvement in all the parameters after yoga intervention. Mean waist circumference decreased from 99.66 ± 5.36 cm to 92.17 ± 5.40 cm, while fasting blood glucose declined from 122.84 ± 11.07 mg/dL to 107.30 ± 10.13 mg/dL ($p<0.0001$). There was also a significant decrease in total cholesterol, triglycerides, LDL cholesterol, systolic blood pressure, and diastolic blood pressure, while HDL cholesterol significantly increased (all $p<0.0001$). WHOQOL-BREF scores improved from 59.06 ± 5.78 at baseline to 67.83 ± 6.89 at six months ($p<0.0001$).

Conclusion: Yoga practice has a significant effect on metabolic, cardiovascular and quality of life parameters of metabolic syndrome patients. Yoga can be used as a safe, effective and sustainable complementary approach in the holistic management of MetS.

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1. INTRODUCTION

Metabolic syndrome (MetS) is a combination of interrelated metabolic abnormalities that include central obesity, hypertension, dyslipidemia, insulin resistance and impaired glucose metabolism [1]. These risk factors often occur together and significantly raise the risk of type 2 diabetes mellitus, cardiovascular disease, stroke and early death [2]. In recent decades, the incidence of metabolic syndrome has also risen significantly with the rapid urbanization, sedentary lifestyle, unhealthy eating habits and obesity [3]. In India and other developing nations, rising prevalence of metabolic syndrome has become a public health problem and is a major burden on the health-care costs and quality of life [4].

The pathophysiology of metabolic syndrome is complex and multifactorial, with the involvement of genetic susceptibility, environmental influences and behavioral factors [5]. Central obesity and visceral adiposity are thought to be the main contributors to insulin resistance, chronic low-grade inflammation, oxidative stress and endothelial dysfunction [6]. These metabolic disorders result in raised triglyceride levels, lowered high-density lipoprotein (HDL) cholesterol, hypertension and impaired glucose regulation, which all increase cardiovascular risk [5]. While there are pharmaceutical drugs to treat single features of metabolic syndrome, long-term treatment is costlier, has side effects and is less likely to be followed by the patient [7]. Therefore, lifestyle modifications remain the mainstay of prevention and management [7,8].

Yoga is an ancient mind–body practice that integrates physical postures (asanas), breathing exercises (pranayama), relaxation techniques, and meditation to foster physical, mental and emotional well-being [9]. Yoga has become a popular alternative and non-pharmacological treatment for chronic lifestyle disorders in recent years [10]. Yoga is not as high impact as traditional exercise programs, can be easily modified and is appropriate for people of all ages and fitness levels [11]. It has been demonstrated that regular yoga practice can enhance autonomic balance, decrease stress hormone levels, improve insulin sensitivity and promote weight reduction and improve lipid metabolism [12]. These effects indicate that yoga can have a positive effect on one or more of the metabolic syndrome factors [13].

Yoga-based interventions have shown to be effective in reducing waist circumference, blood pressure, fasting blood glucose, total cholesterol, triglycerides, and low-density lipoprotein (LDL) cholesterol, with improvement in high-density lipoprotein (HDL) cholesterol and quality of life in several clinical studies [14,15]. Additionally, yoga has been linked to decreased psychological stress, enhanced emotional health, and increased healthy behaviors. However, the literature on the long-term efficacy of yoga in the holistic management of metabolic syndrome is still sparse, especially in Indian population. Hence, the present study was undertaken with an objective to find the effect of yoga practice on metabolic syndrome by measuring anthropometric parameters, glycaemic status, lipid profile, blood pressure and health related quality of life.

2. MATERIALS AND METHODS

The present study is a prospective observational study conducted in the Department of Medicine of Muzaffarnagar Medical College and Hospital, Uttar Pradesh, for 18 months from Jan 2025 to 2026. The patients were selected by purposive sampling from the outpatient, inpatient and casualty department and a total of 60 patients with metabolic syndrome were selected. Adults with a body mass index (BMI) > 25 kg/m², willing to practice yoga regularly, who gave written informed consent and were non-smokers and non-alcoholics were eligible. Patients were excluded if they had severe obesity-related complications, secondary obesity, physical disabilities that precluded yoga practice, or were taking medications that influenced lipid or glucose metabolism, or were not practicing yoga regularly or unable to provide consent.

All participants were given a detailed baseline assessment after enrollment, which included demographic characteristics, medical history, duration of illness, comorbidities, medication history, dietary habits, and physical activity profile. A thorough clinical examination was conducted which included general and systemic examination. Standardized techniques were used for anthropometric measurements including height, weight, waist circumference, hip circumference, waist–hip ratio and BMI. Systolic and diastolic blood pressure were taken with a regular sphygmomanometer. Fasting blood glucose and fasting lipid profile (total cholesterol, triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL)) were the primary laboratory investigations conducted.

The yoga intervention was delivered by a qualified yoga teacher with medical supervision. Participants were first provided with supervised training to ensure proper execution of the yoga practices and then asked to practice yoga daily at home with at least one supervised session per week for 24 weeks. Each session was about 55 minutes, which included 10 minutes warm up, 20 minutes yogasana, 10 minutes pranayama, 10 minutes mudra and bandha and 5 minutes relaxation in Shavasana. For those physically challenged, appropriate adaptations were made that focused on breathing and relaxation. Compliance was assessed by self-kept diaries, which recorded the daily practice of yoga, medication, food consumption, and any adverse events. A follow-up with participants was carried out for six months, and the evaluations were made at baseline, after three months and after six months. The anthropometric parameters, blood pressure readings and biochemical investigations were repeated at each follow-up. Health-related quality of life was assessed at baseline and end of study using World Health Organization Quality of Life-BREF (WHOQOL-BREF) questionnaire.

The data were stored on Microsoft Excel and analysed with Statistical Package for the Social Sciences (SPSS) software version 26.0. The continuous variables were presented as mean ± standard deviation (SD) and the categorical variables as frequency and percentages. Repeated-measures analysis of variance (ANOVA) was used to analyse changes in study parameters over various follow-up periods. Statistically significant results were defined as a p value <0.05. Before the study, ethical clearance was taken from the Institutional Ethics Committee of Muzaffarnagar Medical College.

3. RESULTS

The study included 60 participants with metabolic syndrome. The largest proportion of participants belonged to the 31–40 years age group (33.3%), followed by 41–50 years (30.0%), while 21.7% were aged 51–60 years and 15.0% were aged 21–30 years. Males constituted 55.0% of the study population and females 45.0%. The mean BMI was 30.43 ± 2.46 kg/m² and the mean waist–hip ratio was 0.96 ± 0.05. A positive family history of diabetes was reported by 18.3% of participants. Most participants followed a mixed diet (61.7%), and a sedentary lifestyle was observed in 56.7% of the study population. (Table 1)

Table 1: Baseline Sociodemographic and Clinical Characteristics of Study Participants (N = 60)

Variable	Category	Value
Age (years)	21–30	9 (15.0%)
	31–40	20 (33.3%)
	41–50	18 (30.0%)
	51–60	13 (21.7%)
Gender	Male	33 (55.0%)
	Female	27 (45.0%)
BMI (kg/m²)	Mean ± SD	30.43 ± 2.46
Waist-Hip Ratio	Mean ± SD	0.96 ± 0.05
Family History of Diabetes	Yes	11 (18.3%)
Diet Pattern	Vegetarian	23 (38.3%)
	Mixed	37 (61.7%)
Lifestyle Pattern	Sedentary	34 (56.7%)
	Moderate	20 (33.3%)
	Heavy	6 (10.0%)

Fatigue was the most frequently reported symptom, affecting 27.3% of males and 37.0% of females. Polyuria and dyspnoea on exertion were reported by 27.3% of males and 25.9% of females each, while blurred vision was more common among males (24.2%) than females (14.8%). Approximately one-fifth of participants in both genders reported no symptoms. Regarding symptom duration, the majority had symptoms for ≥5 years, accounting for 63.6% of males and 51.9% of females, indicating a prolonged disease course among most participants. (Table 2)

Table 2: Symptom Profile and Duration of Symptoms Among Participants

Variable	Category	Male (n=33)	Female (n=27)
Symptoms	Fatigue	9 (27.3)	10 (37.0)
	Blurred vision	8 (24.2)	4 (14.8)
	Polyuria	9 (27.3)	7 (25.9)
	Dyspnoea on exertion	9 (27.3)	7 (25.9)
	No symptoms	7 (21.2)	6 (22.2)
Duration of Symptoms	<1 year	2 (6.1)	1 (3.7)
	1–2 years	2 (6.1)	3 (11.1)
	3–4 years	8 (24.2)	9 (33.3)
	≥5 years	21 (63.6)	14 (51.9)

A significant improvement in anthropometric and glycaemic parameters was observed following yoga practice. Mean waist circumference decreased progressively from 99.66 ± 5.36 cm at baseline to 96.14 ± 5.32 cm at 3 months and 92.17 ± 5.40 cm at 6 months. Similarly, fasting blood sugar levels declined significantly from 122.84 ± 11.07 mg/dL at baseline to 116.92 ± 10.71 mg/dL and 107.30 ± 10.13 mg/dL at 3 and 6 months, respectively ($p<0.0001$). (Table 3)

Table 3: Changes in Anthropometric and Glycaemic Parameters Following Yoga Practice

Parameter	Baseline	3 Months	6 Months	p-value
Waist Circumference (cm)	99.66 ± 5.36	96.14 ± 5.32	92.17 ± 5.40	<0.0001
Fasting Blood Sugar (mg/dL)	122.84 ± 11.07	116.92 ± 10.71	107.30 ± 10.13	<0.0001

The lipid profile showed marked improvement during the study period. Mean total cholesterol decreased from 212.34 ± 17.18 mg/dL at baseline to 169.42 ± 14.65 mg/dL at 6 months, while triglyceride levels reduced from 211.96 ± 20.37 mg/dL to 170.46 ± 17.26 mg/dL. LDL cholesterol also declined significantly from 126.40 ± 15.93 mg/dL to 101.32 ± 12.74 mg/dL. In contrast, HDL cholesterol increased from 37.25 ± 4.59 mg/dL at baseline to 43.07 ± 5.50 mg/dL at 6 months. All changes were statistically significant ($p<0.0001$). (Table 4)

Table 4: Changes in Lipid Profile Following Yoga Practice

Parameter	Baseline	3 Months	6 Months	p-value
Total Cholesterol (mg/dL)	212.34 ± 17.18	187.54 ± 16.27	169.42 ± 14.65	<0.0001

Triglycerides (mg/dL)	211.96 ± 20.37	187.89 ± 18.57	170.46 ± 17.26	<0.0001
HDL Cholesterol (mg/dL)	37.25 ± 4.59	40.83 ± 5.16	43.07 ± 5.50	<0.0001
LDL Cholesterol (mg/dL)	126.40 ± 15.93	112.39 ± 14.19	101.32 ± 12.74	<0.0001

Both systolic and diastolic blood pressure demonstrated significant reductions following yoga intervention. Mean systolic blood pressure decreased from 144.78 ± 7.92 mmHg at baseline to 128.57 ± 7.56 mmHg at 6 months, while mean diastolic blood pressure declined from 93.22 ± 4.25 mmHg to 82.81 ± 4.44 mmHg over the same period. These improvements were highly significant statistically (p<0.0001). (Table 5)

Table 5: Changes in Blood Pressure Following Yoga Practice

Parameter	Baseline	3 Months	6 Months	p-value
Systolic Blood Pressure (mmHg)	144.78 ± 7.92	137.68 ± 7.80	128.57 ± 7.56	<0.0001
Diastolic Blood Pressure (mmHg)	93.22 ± 4.25	88.39 ± 4.17	82.81 ± 4.44	<0.0001

Quality of life improved significantly during follow-up as reflected by the WHOQOL-BREF scores. The mean score increased from 59.06 ± 5.78 at baseline to 63.67 ± 6.12 at 3 months and further to 67.83 ± 6.89 at 6 months. The observed improvement was statistically significant (p<0.0001), suggesting a positive impact of yoga practice on overall well-being and quality of life among participants with metabolic syndrome. (Table 6)

Table 6: Changes in Quality-of-Life Following Yoga Practice

WHOQOL-BREF Score	Mean ± SD
Baseline	59.06 ± 5.78
3 Months	63.67 ± 6.12
6 Months	67.83 ± 6.89
p-value	<0.0001

4. DISCUSSION

This study assessed the impact of the yoga intervention on metabolic, anthropometric, cardiovascular and quality of life parameters in MS patients after 6 months. The study population was mainly middle-aged adults with the age group 31-40 years having the largest number of respondents and the male population was slightly higher. Such findings are similar to those of Sorout et al., who found a mean age of 44.7 ± 11.04 years with a majority of males, and Souza et al. and Sohl et al., who found mean ages of 52.81 and 58.6 years, respectively [13,16,17]. The subjects of this study were obese and centrally adipose with a mean BMI of 30.43 ± 2.46 kg/m2 and mean WHR of 0.96 ± 0.05. Sorout et al. and Sohl et al. reported similar results, highlighting obesity as a key factor in the pathogenesis of metabolic syndrome [13,16]. Over half of the subjects were sedentary, adding to the well-known relationship between physical inactivity and the rising incidence of metabolic abnormalities.

Waist circumference was seen to be significantly reduced after yoga practice from 99.66 ± 5.36 cm at baseline to 92.17 ± 5.40 cm at 6 months (p<0.0001). This decrease reflects a significant decrease in central obesity, which is one of the main factors in the metabolic syndrome. Similar results were found by Sorout et al., who showed that there was a significant decrease in waist circumference, hip circumference, and waist–hip ratio after yoga-based lifestyle intervention [16]. The yoga-based therapy also resulted in a significant reduction of body weight, BMI and waist circumference as reported by Shashikiran HC et al., and meaningful reduction of central adiposity after yoga practice was reported by Yu et al. [18,19]. Besides, there was a significant reduction in fasting blood sugar level from 122.84 ± 11.07 mg/dl to 107.30 ± 10.13 mg/dl during the study period. Sorout et al., Shashikaran HC et al., and Souza et al., also reported significant decrease in fasting glucose levels following yoga intervention [16-18]. These results indicate that yoga can help in making the body more sensitive to insulin and better utilize glucose due to better autonomic regulation and less stress-related hormonal activity.

The present study also showed significant improvement in lipid parameters. Total cholesterol, triglycerides and LDL cholesterol levels were significantly reduced while HDL cholesterol levels were increased from 37.25 ± 4.59 mg/dl to 43.07 ± 5.50 mg/dl (p<0.0001). Such findings are in line with those of Sorout et al., who found that total cholesterol and LDL concentrations were significantly lowered while HDL concentrations were improved after yoga intervention [16]. Shashikaran HC et al., and Souza et al [17,18] reported similar beneficial effect on lipid metabolism. The improvement in lipid parameters may be due to increase in energy expenditure, improved insulin sensitivity, reduction in sympathetic activity and beneficial modulation of lipid metabolism with regular yoga practice. Overall, these results suggest that yoga can positively affect several metabolic risk factors at once, and thus, lower the overall cardiovascular risk in people with metabolic syndrome.

There was a significant decrease in both systolic and diastolic blood pressure during the follow-up period (systolic blood pressure: 144.78 ± 7.92 mmHg to 128.57 ± 7.56 mmHg; diastolic blood pressure: 93.22 ± 4.25 mmHg to 82.81 ± 4.44 mmHg; p<0.0001). These findings are similar to those of Sorout et al., Yu et al., and Souza et al., who showed a significant reduction in BP after yoga-based interventions [16,17,19]. The mechanisms by which yoga exerts beneficial effects on BP might include an increase in parasympathetic activity, increased vascular compliance, a decrease in cortisol production, and a decrease in sympathetic overactivity. Moreover, there was an improvement in quality of life in the

present study, with the WHOQOL-BREF scores at baseline being 59.06 ± 5.78 and at six months being 67.83 ± 6.89. Sohl et al. also reported significant improvement in physical functioning and general health domains among those who practiced yoga [13] which is similar to the improvement observed in health-related quality of life in the present study. The findings suggest that yoga can be used as an adjunctive lifestyle intervention for metabolic syndrome, as it improves both physiological and psychosocial parameters, indicating the holistic benefits of yoga.

There were some limitations in the present study. It was an observational study conducted in a single center with a relatively small sample size, so the results may not be applicable to the general population. It was challenging to conclude that all the improvements were due to yoga intervention because there was no control group. Further, the compliance with the home yoga practice was mostly based on self-reported diaries, which could have led to reporting bias. Future large-scale, randomized controlled trials with longer follow-up are needed to confirm the long-term effects of yoga in the management of metabolic syndrome.

5. CONCLUSION

The present study showed that regular yoga practice was found to be significantly associated with improvement of various parameters of metabolic syndrome such as central obesity, fasting blood glucose, lipid profile and blood pressure. In addition, there was a significant improvement in health-related quality of life during the 6-month intervention period. These results indicate that yoga is safe, feasible and effective as a non-pharmacological therapy for management of metabolic syndrome. Structured yoga practice in lifestyle modification programs could help to improve metabolic control, decrease cardiovascular risk and enhance overall quality of life in people with metabolic syndrome.

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