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Original Research

Stress Attenuation Effect of Combined Approach of Yoga and Diet Intervention Among Metabolic Syndrome Patients.

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Abstract

Background: Persistent exposure to psychosocial stress is linked to an increased risk of metabolic disease, including obesity, cardiovascular disease (CVD), and Type-2 diabetes mellitus (T2DM). Metabolic syndrome is driven by an unhealthy lifestyle encompassing a sedentary lifestyle and unhealthy diet as well as psychological distress, which potentially triggers these metabolic derailments. Various mind-body practices, such as postures, breathing, meditation, and relaxation, are included in yoga. Studies suggest that even one yoga session can improve cognitive function, oxygen saturation, baroreflex sensitivity, sympathovagal balance, and the body's ability to recover from stressful stimuli. Therefore, this study aimed to explore the stress attenuation effect of a combined approach of yoga and diet intervention among metabolic syndrome patients.

Methodology: In this study we randomized 200 subjects diagnosed with metabolic syndrome as per the Joint interim statement 2009 into control and combined (yoga+diet) groups according to their intervention which was given for 6 months. Anthropometric, physiological, perceived stress score and biochemical parameters were collected at baseline, 3 months and 6 months.

Results: The study's findings show that, at three and six months from baseline, the combined yoga with diet approach significantly reduced metabolic risk factors (waist circumference, SBP, DBP, fasting blood glucose, and triglycerides) and improved HDL. At three and six months following the combined (yoga+diet) intervention, the perceived stress score also showed a substantial reduction.

Conclusions: Combined (yoga+diet) interventions are effective in lowering the risk of metabolic syndrome and perceived stress.

Keywords: Metabolic Syndrome; Perceived Stress; Yoga; Diet.

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Quick Response Code:

Introduction

Metabolic syndrome (MetS) is a cluster of metabolic abnormalities that includes hypertension, central obesity, insulin resistance, and atherogenic dyslipidemia. MetS is highly prevalent and increasing in most parts of the world.[1] Modern society has brought with it profound changes in lifestyle and an increased incidence of atherosclerotic vascular disease. Increased body weight, unhealthy diets, and sedentary lifestyles are contributing to rise in blood pressure and disturbances in metabolism that raise the risk of atherothrombotic situations. In fact, obesity, insulin resistance, and diabetes are becoming a public health problem of epidemic proportions.[2] Chronic or very intensive stressors characterised by uncontrollability and unpredictability are damaging to body functions, increasing disease susceptibility in vulnerable individuals.[3] These stressors can also modify the course of disease among those already living with a disease.

Persistent exposure to psychosocial stress is linked to an increased risk of metabolic disease, obesity, cardiovascular disease (CVD), and Type-2 diabetes mellitus (T2DM).[4] Delineating the behavioral, physiological, and molecular mechanisms by which stress adversely affects these endpoints may uncover important opportunities for therapeutic intervention.[4] The sympathetic nervous system is activated almost immediately upon exposure to an acute stress stimulus and provides for rapid, but transient, physiological responses via direct catecholaminergic innervation of peripheral organs. Additionally, sympathetic drive to the adrenal medulla elicits the release of catecholamines into systemic circulation.[5] Together, this increased sympatho-adrenomedullary (SAM) activity facilitates the mobilization of stored energy, increases heart rate and blood pressure. HPA axis activation provides a relatively slower, but amplified and sustained response to stress.[6] Corticotrophin releasing hormone (CRH) is synthesized in hypothalamic neurons, released at the median eminence, and travels via the portal circulation to the anterior pituitary, where it stimulates the release of adrenocorticotropic hormone (ACTH) into systemic circulation. ACTH stimulates the synthesis and secretion of glucocorticoids from the adrenal cortex. Glucocorticoids act at their receptors to exert several effects, including the sustained mobilization of fuels. For example, glucocorticoid-signaling increases lipolysis and the release of fatty acids from adipose tissue and increases hepatic gluconeogenesis. Glucocorticoid-signaling both decreases pancreatic insulin production and increases insulin resistance, promoting the greater availability of plasma glucose.[7-9] Frequent and persistent override of metabolic homeostasis, required to mobilize fuels in response to stressful stimuli, may make metabolic regulatory systems particularly vulnerable to adverse consequences.[10] Consistent with this possibility, chronic stress alters feeding behavior and promotes obesity, and is thought to be an important risk factor for a number of metabolic diseases, including cardiovascular disease (CVD), Type-2 diabetes mellitus (T2DM). Furthermore, an early life history of stress exposure can alter adult behavioral and physiological reactions to acute and chronic stress, increasing the risk of diseases in later life. MetS seems to be driven by an unhealthy lifestyle which includes sedentary lifestyle, unhealthy diet as well as psychological distress, which potentially trigger these metabolic derailments.[11] While stress increases metabolic activity and dissociates physiological and psychological processes, relaxation practices tend to induce mind-body coherence or a sense of psychological and physiological equilibrium that counteracts stress by inducing a relaxation response.[12] Yoga includes a range of mind-body practices that include postures, breathing, meditation and relaxation, and studies suggest that a single yoga session can lead to improvements in cognitive performance, baroreflex sensitivity, oxygen saturation, sympathovagal balance and enhance recovery after stressful stimuli.[13,14] Therefore, this study aimed to explore stress attenuation effect of combined approach of yoga and diet intervention among metabolic syndrome patients.

Materials And Methods:

Trial design, setting, and ethics:

This study was conducted in the department of Physiology and Medicine, Rajasthan University of Health Sciences College of Medical Sciences and Associated Hospitals, Jaipur, Rajasthan, over a year period from November 2021 to November 2022. Approved CTRI number for the study was CTRI/2023/12/060553. Institutional ethical approval was taken from Rajasthan University Health Sciences-College of Medical Sciences Ethics Committee with Institutional Ethical Number RUHS-College of Medical Sciences/Ethics Comm./2021/72, and written informed consent was taken before data collection.

Subject recruitment:

Patients aged 18–60 years were voluntarily recruited for the study among those attending our outpatient departments at Government RDBP Jaipuria Hospital. To be enrolled in the study, subjects were screened for eligibility and had to have three or more of the following cardio-metabolic risk factors to meet the diagnosis of MetS as defined by Joint Interim Statement (JIS), 2009.[15] (1) WC 40 inch in males; 30 inch in females (for Asians); (2) triglycerides (TG) 150 mg/dl; (3) reduced HDL-C <40 mg/dl in males; <50 mg/dl in females; (4) elevated systolic blood pressure (SBP) 130 and/or diastolic blood pressure (DBP) 85 mmHg; (5) elevated FPG 100 mg/dl. Exclusion criteria were uncontrolled T2DM, uncontrolled hypertension, pregnancy, lactation, and women planning pregnancy during the trial period, history of psychiatric disorders, regular use of nonsteroidal anti-inflammatory drugs, heavy alcohol consumption, smoking, and those who were unable to perform yoga.

Standardization of study groups and confounders: All metabolic syndrome study subjects were randomly allocated into combined (yoga + diet group) and control groups to minimize selection bias. Yoga and breathing practices training were given to all subjects of combined (yoga + diet) group by a certified yoga instructor based on yoga from the Krishnamacharya tradition and diet recommended by certified dietician. Compliance of intervention was checked properly and routinely.

Sample Size:

Sample Size calculated for the study was 96 with 95% degree of confidence, sample proportion 50% and margin of error +/-10%. Therefore, the considerable sample size for the study due to dropout or non-response subjects was 100 and it was same for all groups included in this study.

Randomization: Random numbers list was created by computerized random number generator. Subjects were randomly allocated into control and combined (yoga+ diet) group. The blinding of group assignment was not possible due to the nature of the active yoga intervention. However, the study personnel who performed the assessment of the outcomes and the statistician who analyzed the data were not aware of the group assignment.

Yoga + diet group: In this group, the given intervention was yoga asana and pranayama with tailored diet plan.

Controls: No intervention was given in this group.

All the subjects were on their standard medicine prescribed by their clinicians.

Intervention:

Combined (Yoga+ diet) group: In this group the given intervention was of combined type yoga and dietary modification. Yoga and breathing practices training were given by certified yoga instructor based on yoga from the Krishnamacharya tradition.[16] These sessions were 45 min 6 days in a week over a period of 6 months (Table 1).

Table 1: Yoga (Asanas) and Breathing Practices (Pranayama) protocol.

S.No.	Activity (Sanskrit Name)	Time
Asanas		
1.	Prayer	2 min
2.	Tadasana	2 min
3.	Virabhadrasana	2 min
4.	Urdhava mukha svanasana	3 min
5.	Utkatasana	2 min
6.	Eka pada apanasana	3 min
7.	Jathara paravritti	2 min
8.	Apanasana	3 min
9.	Shavasana	8 min
Breathing Practices (Pranayama)		
1.	Nadi sodhana	3 min
2.	Kapalabhati	4 min
3.	Kukkuriya Pranayama	2 min
4.	Bhastrika Pranayama	2 min
5.	Savitri	3 min
6.	Pranava Pranayama	2 min
7.	Bhramari Pranayama	2 min
Total Time		**45 min**

A certified dietitian developed a customized diet plan for each participant based on Asian Indian dietary standards to prevent metabolic syndrome.[17] It may be summarized as follows: 50–60% carbohydrates, 30–40% total fat, 10–15% monounsaturated fat, 5–8% polyunsaturated fat, 200–300 mg cholesterol, 10–15% protein, 25–40g dietary fiber, and less than 5g salt made up the recommended daily diet (Table 2). Compliance was checked by reviewing diaries in which they are instructed to enter what are they taking in diet.

The subjects received the diet plan as a written diet plan. Additionally, it was mandated that the subjects keep a daily food log and bring it with them to the hospital as proof.

To facilitate and guide home practice of participants, video recording clips of the yoga sessions recorded under direction of the certified yoga instructor in RUHS College of Medical Sciences were given to the participants. And data was collected at baseline, at 3 months and 6 months of intervention from the participants.

Table 2: Daily Diet Plan for the combined (yoga + dietary) group.

Early Morning	1 cup tea or coffee, 2 pieces marialite/digestive/nutritive choice
Breakfast	1 glass Milk, 1 bowl Veg Poha/ Upma/ Daliya/ Sewaiyan/ Oats or 2-3 pcs Idli + Chutney/ 2 pcs Uttapam + Chutney or 1 Chapati + 1 bowl Vegetable, 5 Almonds, 2 Walnuts (soaked overnight).
Mid-Morning	1 glass Buttermilk/ Coconut water/ Lemon water, 1 Seasonal Fruit.
Lunch	1 big bowl salad or soup, 2 missi chapati, 1 bowl dahi or veg raita, 2 bowl seasonal vegetable (Less of Oil)
Evening Tea	1 cup tea or coffee, 1 bowl roasted chana chaat/ sprout, chaat (Add lots of salad in it)
Dinner	1 big bowl salad soup, 2 chapati, 1 bowl dal, 2 bowl seasonal vegetable (Less of Oil).

Assessments:

Anthropometric and blood pressure measurements: The height (in cm) and weight (in kg) were calculated in accordance with the NHANES guidelines using a stadiometer and a calibrated weighing scale, respectively. The BMI was calculated using the weight (kg)/height (m2) formula. The individuals were asked to stand with their heels together and have the circumference of their waist measured at the level of the umbilicus using a linen measuring tape.[18] Both the systolic blood pressure (SBP) and the diastolic blood pressure (DBP) were determined using the sphygmomanometer after a 15–30-minute period of stillness.[19]

Biochemical investigations

Subjects were instructed to appear after an overnight fast of 8 to 10 hours for the biochemical tests. A tourniquet-tied vein was used to collect 5 ml of overnight fasting blood into a vacutainer containing gel clot activator. The remaining generated components were settled, and the serum was separated by centrifuging the blood for 10 min. at 10,000 rpm. Using commercially available test kits, the concentration of serum HDL, TG, and fasting blood glucose (FBG) was calculated.[20, 21]

Perceived stress assessment

Cohen's Perceived Stress Scale[22] was used to estimate the perceived stress. One of the conventional methods for assessing stress is the Perceived Stress Scale (PSS). This scale asks about a person's thoughts and feelings throughout the last month. Each time, the respondent was asked to rate the frequency with which they thought or felt a particular manner. For each question following alternatives were chosen: 0 - never 1 - almost never 2 - sometimes 3 - fairly often 4 - very often. It is an indicator of how stressful

living circumstances are. PSS demonstrated satisfactory predictability and reliability when linked with anxiety, depression, and life event ratings.

MetS Z- score

Metabolic syndrome risk score (MetS Z- score) was used to assess the metabolic risk, which was calculated by summing the standardized values for waist circumference, triglycerides, HDL, blood pressure, and fasting glucose. A higher risk score indicates a less favorable metabolic profile.

Statistical analysis: Microsoft Excel was used to organize the collected data. For data that was normally distributed, mean ±SD was computed. Using SPSS software (SPSS-28 version), analysis of variance (ANOVA) and Pearson correlation were used to determine the level of statistical significance ($p< 0.05$) and correlation.

Results:

Table 3: Distribution of subjects in the study groups based on their perceived stress score.

	Control (N=100)	Combined (yoga+diet) (N=100)	Total (N=200)
Low	6	11	17 (8.5%)
Moderate	69	55	124 (62%)
High	25	34	59 (29.5%)

Table 3 depicts the distribution of subjects in different study groups based on their perceived stress score. 8.5% study subjects had low stress, 62% had moderate stress and 29.5% had high stress out of overall 200 MetS subjects.

Table 4: Distribution of subjects based on their sociodemographic distribution in different study groups.

		Control			Combined (yoga+diet)		
		Low Stress	**Moderate Stress**	**High Stress**	**Low Stress**	**Moderate Stress**	**High Stress**
Age		**38.67±11.62**	**42±11.61**	**44±12.19**	**40.27±13.65**	**41.14±11.18**	**43.23±12.78**
Location	Rural	1	13	6	2	5	4
	Urban	5	56	19	9	50	30
Marital Status	Married	5	59	22	7	41	29
	Unmarried	0	6	2	3	8	4
	Widow	1	4	1	1	6	1
Socioeconomic Status	Upper Lower	2	29	10	1	13	6
	Upper Middle	3	27	9	6	28	16
	Upper	1	1	0	0	2	0
	Lower Middle	0	12	6	4	12	12

Table 4 depicts the distribution of subjects based on their sociodemographic status in different study groups. No significant difference was observed in age of both groups. In both the groups control and combined (yoga+diet) subjects had moderate to high stress were of urban region. Moderate to high stress was also prevalent in married subjects of study population. Moderate to high stress was also more prevalent in upper lower, upper middle and lower middle socioeconomic class.

Table 5 depicts the distribution of different metabolic variables in the control group. No significant difference was observed in metabolic variables from baseline to six months, but significantly more in moderate and high stress group than low stress group. But HDL was significantly low in moderate and

high stress groups. The perceived stress score was also not decreased significantly from baseline to six months. MetS Z- score was not decreased significantly at three and six months from baseline (p>0.05).

Table 5: Distribution of different metabolic variables in control group.

Control		Baseline	3 months	6 months	P value
Weight	Low	76±14.29	76.54±14.25	77.54±14.54	0.948
	Moderate	71.78±11.21	72.56±11.15	73.09±11.42	0.961
	High	74.94±11.66	75.35±11.78	76.23±11.9	0.942
BMI	Low	26.21±4.90	26.40±4.95	26.75±5.08	0.947
	Moderate	27.49±4.69	27.8±4.70	27.99±4.75	0.969
	High	29.27±4.74	29.43±4.77	29.77±4.8	0.947
WC	Low	38±3.70	38.11±3.69	38.97±3.52	0.588
	Moderate	38.56±3.80	38.72±3.82	37.41±4.81	0.391
	High	40.27±4.68	40.33±4.71	40.51±4.7	0.985
SBP	Low	140.36±17.41	133.64±12.42	127.27±9.64	0.024*
	Moderate	138.18±19.91	130.33±13.02	126.84±11.58	0.154
	High	142.76±29.27	135.76±18.58	129.64±15.26	0.205
DBP	Low	88.72±9.43	84±7.27	80.91±3.01	0.022*
	Moderate	88.25±10.07	84.44±6.74	81.31±4.13	0.030*
	High	90.76±16.02	86.35±8.03	81.23±3.88	0.006*
FBG	Low	133.06±49.18	129.45±23.98	124.45±12.28	0.592
	Moderate	138.96±55.64	128.1±30.09	127.36±15.58	0.665
	High	163.31±46.8	147.05±25.52	153.56±13.88	0.208
HDL	Low	44.91±10.67	43.38±10.94	43.76±10.61	0.942
	Moderate	39.83±10.55	39.37±10.56	38.96±10.52	0.978
	High	37.51±10.53	37.11±10.41	36.55±10.29	0.966
TG	Low	189.36±59.42	200.02±60.85	209.6±56.67	0.689
	Moderate	199.44±55.99	201.29±55.62	202.35±53.44	0.992
	High	197.86±45.28	197.24±43.95	199.7±44.82	0.972
PSS	Low	11.83±0.98	11.46±1.38	12.71±2.81	0.016*
	Moderate	21.73±3.04	20.86±3.68	21.55±3.46	0.645
	High	28.84±1.59	27.28±4.46	27.16±4.81	0.693
MetS Z- Score	Low	0.08±0.01	0.07±0.03	0.05±0.01	0.000*
	Moderate	0.16±0.07	0.15±0.04	0.17±0.03	0.053
	High	0.23±0.10	0.21±0.14	0.18±0.11	0.449

*Significant – p value ≤ 0.05

Table 6 depicts the distribution of different metabolic variables in a combined (yoga+diet) group. Metabolic variables like weight, BMI, WC, SBP, DBP, FBG, and TG were significantly high in moderate and high stress groups. But HDL was significantly low in moderate and high stress groups. Metabolic syndrome variables (weight, BMI, WC, SBP, DBP, FBG, and TG) were significantly decreased after intervention from baseline to six months. And HDL was significantly increased after intervention from baseline to six months. Perceived stress score was also significantly decreased after intervention from baseline to six months. MetS Z- score was also decreased significantly after intervention at three and six months from baseline (p<0.05).

Table 6: Distribution of different metabolic variables in combined (yoga+ diet) group.

Y+D		Baseline	3 months	6 months	P value
Weight	Low	65.83±9.52	64.33±9.46	60.33±8.14	0.145
	Moderate	74.23±12.86	72.46±12.41	68.13±11.09	0.268
	High	75.2±12.38	73.24±12.22	68.88±10.91	0.246
BMI	Low	26.84±2.31	26.22±2.40	24.64±2.21	0.011*
	Moderate	29.09±4.97	28.42±4.88	26.72±4.39	0.271
	High	28.49±4.94	27.77±4.90	25.03±4.66	0.046*
WC	Low	38.97±3.20	38.73±3.24	37.99±3.24	0.590
	Moderate	40.73±3.40	40.47±3.39	39.78±3.42	0.654
	High	41.37±4.84	41.12±4.82	40.52±4.84	0.851
SBP	Low	135.33±12.5	131.33±12.5	129±8.27	0.444
	Moderate	138.17±12.55	134.9±10.6	128±6.67	0.007*
	High	143.44±13.84	138.72±11.44	129.92±6.36	0.001*
DBP	Low	87±6.29	84.33±5.85	83±3.29	0.236
	Moderate	88.72±6.98	86.4±5.78	82.61±4.20	0.006*
	High	91.12±5.97	87.92±5.55	82.48±3.93	0.000*
FBG	Low	126.33±35.48	112.33±28.81	98.33±15.74	0.026*
	Moderate	128.9±38.04	113.13±26.97	94.67±18.39	0.002*
	High	137.27±50.02	121.64±34.25	98.16±25.12	0.004*
HDL	Low	43.17±18.01	45.96±16.91	50.31±16.60	0.469
	Moderate	45.42±14.37	47.22±12.26	55.27±12.41	0.019*
	High	37.51±7.72	40.65±6.67	45.28±6.86	0.006*
TG	Low	152.09±34.72	133.73±29.40	96.59±11.13	0.000*
	Moderate	172.62±49.38	150.84±43.33	106.46±25.9	0.000*
	High	170.23±44.08	141.11±26.47	99.5±13.71	0.000*
PSS	Low	11.83±0.98	9.5±1.38	6.5±2.81	0.000*
	Moderate	21.21±3.66	18.41±4.47	15.32±5.90	0.006*
	High	29.08±1.52	24.44±2.50	19.41±4.40	0.000*
MetS Z-Score	Low	-0.02±0.05	-0.09±0.08	-0.13±0.07	0.001*
	Moderate	0.19±0.04	0.08±0.03	-0.11±0.06	0.000*
	High	0.28±0.16	0.14±0.08	-0.06±0.01	0.000*

*Significant – p value ≤ 0.05

Table 7: Correlation of perceived stress score with MetS Z-score in control group.

Correlation of Control	Stress Categories	PSS		
		Baseline (r- value)	3 Months (r- value)	6 Months (r- value)
MetS Z- Score	Low	0.11	0.06	-0.15*
	Moderate	0.19*	0.09	0.12
	High	0.23*	0.17*	0.11

*Significant – p value ≤ 0.05; r = Pearson correlation coefficient

Table 8: Correlation of perceived stress score with MetS Z-score in combined (yoga+diet) group.

Correlation of Combined (yoga + diet)	Stress Categories	PSS		
		Baseline (r- value)	3 Months (r- value)	6 Months (r- value)
MetS Z- Score	Low	0.05	-0.15*	-0.28*
	Moderate	0.20*	0.13	-0.17*
	High	0.18*	-0.15*	-0.32*

*Significant – p value ≤ 0.05; r = Pearson correlation coefficient

Discussion

In this study moderate and high perceived stress subjects were more prevalent among metabolic syndrome population. Janczura et al. also stated that perceived stress is significantly higher in the MetS subjects and perceived stress increased the chances of increased MetS prevalence.[23] A cluster of cardiovascular risk factors has been structured as the metabolic syndrome. Unfortunately, having a sedentary lifestyle, unhealthy diet, and avoidance of physical activity and sports, and in general an unfavorable lifestyle, especially in the industrialized countries has significantly increased prevalence of metabolic syndrome among the people.[24] Those with moderate and high perceived stress levels in this study also had more altered metabolic risk variables. This means there is a two-way link between metabolic disorders and cardiovascular disease and occurrence of stress.[25]

In both the groups control and combined (yoga+diet) subjects had moderate to high stress were of urban region. Similar to the present study, a research by Krishnamoorthy et al. discovered that prevalence of MetS was greater in urban regions compared to tribal areas and rural areas.[26] Additionally, according to Bilog et al., also found that prevalence of MetS was greater in urban regions compared to rural areas.[27] Moderate to high stress was also prevalent in married subjects of this study population but Jung et al. reported that metabolic syndrome and stress were more prevalent in widowed group than married.[28] Moderate to high stress was also more prevalent in upper lower, upper middle and lower middle socioeconomic class. Similar observations were noted in the research conducted by Mohan et al., most of participants belong to middle class and had significantly higher prevalence of MetS and stress.[29] In contrary, studies by Matthews et al, Zhan et al showed that prevalence of MetS was higher among lower socioeconomic status people.[30,31] These differences may be caused by people living unhealthy lifestyles, having higher socioeconomic status, engaging in less physical activity, experiencing stress, consuming excessive amounts of salt, and consuming more red meat in urban areas than in rural ones.[32] The impacts of socioeconomic status on MetS may be attributed to an individual's unhealthy lifestyle, which includes physical inactivity and eating unhealthy diet, as well as habits like alcoholism and smoking. Those with middle and lower socioeconomic class tended to be more likely indulged in smoking and consumption of alcohol.[33] The differences in socioeconomic status as well as rising expenditures of food, healthcare, housing, and educational expenses can all contribute to psychological stress. This is particularly true for people from lower socioeconomic backgrounds. This could make health disparities and MetS-related diseases worse.

No significant difference was observed in metabolic variables from baseline to six months, but significantly more in moderate and high stress group than low stress group. But HDL was significantly low in moderate and high stress groups. The perceived stress score also did not decrease significantly from baseline to six months. No significant decrease was observed in metabolic syndrome risk score (MetS Z- score) at three and six months from baseline in control group.

Metabolic variables like weight, BMI, WC, SBP, DBP, FBG, and TG were significantly high in moderate and high stress groups. But HDL was significantly low in moderate and high stress groups. Metabolic syndrome variables (weight, BMI, WC, SBP, DBP, FBG, and TG) were significantly decreased after intervention from baseline to six months. And HDL was significantly increased after intervention from baseline to six months. Perceived stress score was also significantly decreased after intervention from baseline to six months. Metabolic syndrome risk score (MetS Z- score) was significantly decreased after intervention at three and six months from baseline in combined (yoga+diet) group. This indicates improvement in MetS risk profile. Compared to the control group, the combined (yoga+diet) group had significantly improved metabolic risk factors and perceived stress.

Similarly Seo D.Y. et al. also reported that after 2 months of yoga intervention, body weight & BMI significantly reduced.[34] Annapurna et al. reported that after 3 months of yoga intervention results reduction in all the parameters, SBP, DBP.[35] Dhananjai et al. also reported that 12 weeks of yoga practice includes meditation, pranayam, asana leads to weight loss with reduction of fasting blood glucose, TC, TG, VLDL, LDL and HDL increased.[36] Rao et al. also concluded that the short-term combined approach of yoga-based life-style intervention and diet reduced cardiovascular risk factors in subjects at high-risk of developing cardiovascular disease.[37] Corey et al. concluded that yoga is beneficial for reducing perceived stress with improvement of metabolic profile.[38]

Like the present study, Lau et al. also reported that yoga training was effective in improving the MetS Z-score in metabolic syndrome patients. The decline in MetS Z-score may have been caused by the reduction in fasting glucose and waist circumference, as well as the minimal decrease in triglycerides that was seen in the yoga group following the intervention.[39]

In this study, metabolic syndrome risk factors decreased at three months and six months after intervention. In this study we found significant positive correlation of PSS with MetS Z-score at baseline in both groups. This indicates the direct correlation of two parameters. At three and six months we observed negative correlation of PSS with MetS Z-score in combined (yoga+diet) group. Similarly, Kuo et al. also reported that increased psychological stress scores have been associated with an increased risk of metabolic disorders.[40] Janczura et al. also reported that perceived stress appreciably increased the chance for MetS prevalence.[41] But, Ortega-Montiel et al. found no association between perceived stress and risk of metabolic syndrome.[42]

Yoga practice was positively associated with healthier dietary intake and greater physical activity. Yoga practices may help in reducing body weight or content by increasing energy expenditure directly by adding physical activity. So combined yoga and dietary approach was beneficial for metabolic syndrome risk reduction. Braun et al. reported that yoga and dietary intervention significantly reduced stress and MetS risk factors.[43] Yoga and meditation practices exert positive influence on addictive behaviors. Through the practice of yoga, addicts shift from self-inflicted harm and disrespect toward their bodies to more respectful, caring, and loving behaviors. Eating disorders are specific type of addiction and yoga appears to be beneficial in improving body image disturbances and useful in the recovery from eating disorders.[44] While modern medicine has the ability in many cases to heal physical diseases and alleviate psychological disorders, it is argued that a purely medical approach is far less effective in healing the emotional, intellectual, and personality layers of the human entity. The discipline of yoga and dietary approaches offers individuals a timeless and holistic model of health and healing and although it may not result in the complete elimination of physical diseases and/ or adverse conditions like metabolic syndrome from the body it offers a holistic path of healing.[45]

Limitations:

The limitations of our study consist of the comparison of two groups as control and combined (yoga+diet) groups in which clear picture of effect of intervention was not drawn. Future studies comparing (Yoga vs Diet) individually among metabolic syndrome patients will help fill this research gap. Other limitations include the lack of measurement for confounding factors such as diet and sleep quality.

Conclusion:

In conclusion, we found that combined (yoga+diet) intervention was both feasible and acceptable in patients of metabolic syndrome. This study concluded that the short-term combined approach of yoga-based life-style intervention and diet reduced stress and metabolic syndrome risk factors.

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