

Effects of Yoga and Diet modifications on Body Mass Index Among Middle Aged Women Patients with Metabolic Dysfunction – Associated Fatty Liver Disease (MAFLD) – Pilot Study

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Abstract

Background: Metabolic dysfunction-associated fatty liver disease (MAFLD) formerly known as Non-Alcoholic Fatty Liver Disease (NAFLD) is potentially associated with obesity and increased Body Mass Index (BMI). BMI is a crucial indicator for evaluating obesity-related health risks, including MAFLD. An increased Body Mass Index (BMI) and visceral fat are significant risk factors for MAFLD and are commonly utilized as a non-invasive method to assess metabolic health and liver fat accumulation.

Purpose: This pilot study sought to assess the effects of yoga, dietary changes, and their combined intervention on body mass index (BMI), highlighting their potential role in the prevention and management of MAFLD.

Methods: A total of twenty-one (21) women aged between 40 and 50 were randomly divided into three groups: yoga only (n=7), diet only (n=7), and a combination of both yoga and diet (n=7). Body Mass Index (BMI) was evaluated before and after the intervention. The study was conducted for 8-week period with 6 days intervention each week. An ANCOVA was performed to determine differences among the groups, followed by Scheffé's post-hoc test for pairwise comparisons.

Results: The group that combined yoga with dietary changes experienced a notably larger decrease in BMI than those who practiced yoga alone or followed a diet alone ($p < .05$). There was no significant difference

found between the yoga-only and diet-only groups. These results indicate that the combination of yoga and dietary adjustments may provide enhanced benefits for reduction of body mass index (BMI), which could help lower the risk of NAFLD/MAFLD.

Conclusion: The combination of yoga and dietary changes proves to be more effective in reducing BMI compared to each intervention on its own (only yoga or only diet as intervention). This study supports as a evidence that the implementation of holistic lifestyle strategies that incorporate yoga and dietary changes as a non-pharmacological approach to prevent or manage MAFLD.

Keywords: NAFLD/MAFLD, BMI, Surya Namaskar, Yoga and Diet.

Introduction

Global modernization and urbanization in the 20th and 21st centuries have been connected to unhealthy lifestyle changes. Consequently, the last 3 decades have seen remarkable increases in the mean global body mass index (BMI) and the prevalence of obesity, which are the pathophysiological factors of NAFLD.¹ Metabolic dysfunction-associated fatty liver disease (MAFLD) has emerged as the leading cause of chronic liver disease worldwide, replacing the older non-alcoholic fatty liver disease (NAFLD) terminology to better reflect its physio pathological relationship with metabolic syndrome, insulin resistance, and obesity. Both excessive BMI and visceral obesity are recognized risk factors for NAFLD.² Elevated Body Mass Index (BMI) is a key risk factor for MAFLD and is commonly used as a non-invasive proxy for assessing metabolic health and liver fat accumulation.

The development of MAFLD is associated to excessive body fat, insulin resistance, and systemic inflammation in a complex mode, all of which are affected by poor lifestyle choices such as lack of physical activity and unhealthy eating patterns.³ Present clinical guidelines highlight lifestyle modifications, including weight reduction, increased physical activity, and dietary adjustments as primary treatments for managing MAFLD. In adults with MASLD, dietary and behavioral therapy-induced weight loss should be recommended to improve liver injury, as assessed histologically or non-invasively.³

Yoga, an ancient comprehensive technique which integrates the body and mind through various practices has congregated increasing attention for its potential advantages in enhancing eradicating stress, optimize metabolic parameters and supporting in weight management. yoga practice has potential to control BMI and BP without taking any medication.⁴ Food is an important concept of yoga which determines an individual's body and mind. Dietary modifications, especially those aimed at lowering caloric intake and enhancing nutritional quality, have established effectiveness in decreasing liver fat and body mass index (BMI) in individuals with or at risk for metabolic associated fatty liver disease (MAFLD). Clinical evidence strongly supports the role of lifestyle modification as a primary therapy for the management of NAFLD and NASH.⁵ While both yoga and dietary changes independently contribute to improved metabolic results, the synergistic impact of these two approaches on BMI and, consequently, MAFLD remains insufficiently explored. It is crucial to determine whether a combined strategy offers greater benefits, as this knowledge is vital for developing effective non-pharmacological interventions for MAFLD.

Objective of the Study

This study was conducted to evaluate the separate and synergistic influences of yoga and dietary intervention on Body Mass Index (BMI), aiming to provide awareness into lifestyle approaches which includes yoga and diet for the prevention and management of MAFLD.

Hypothesis

It was hypothesized that:

1. All three intervention groups (yoga, diet, yoga + diet) would show reductions in BMI.
2. The combined yoga and diet group would demonstrate a significantly greater reduction in BMI compared to the yoga-only and diet-only groups.

Methodology

Participants

The study undertaken 21 middle-aged women participants (aged 40–50 years) with elevated Body Mass Index ($BMI \geq 25$) and liver enzymes, considered at risk for metabolic dysfunction-associated fatty liver disease (MAFLD). Participants were randomly assigned to one of three intervention groups: Yoga Only ($n = 7$), Diet Only ($n = 7$), and Combined Yoga & Diet ($n = 7$). Inclusion criteria included simple to moderate non-alcoholic fatty liver patients, stable medical condition, no history of chronic liver disease, and willingness to adhere to intervention protocols. Men, women with menopause and on medications affecting weight or liver enzymes were excluded.

Design and Procedure

This study was a pre-test/post-test experimental study with a between-groups design. The study lasted for 8 weeks. BMI was recorded at baseline (pre-test) and after the intervention period (post-test). Participants provided informed consent, and ethical clearance was obtained from the institutional review board.

Intervention Protocols

- *Yoga Group*: Participants followed a structured yoga program, consisting of Surya Namaskar, asanas (postures), pranayama (breathing techniques), and meditation. Each session lasted approximately 60 minutes, 6 days/week. The training was handled by a yoga expert and periodically monitored.
- *Diet Group*: Participants received individualized dietary plans based on caloric deficit (500 kcal/day below maintenance) and nutritional quality aligned with MAFLD dietary guidelines (reduced saturated fat, increased fiber, moderate carbohydrate intake). Diet adherence was monitored through food logs and weekly check-ins.
- *Yoga & Diet Group*: Participants followed both the yoga and dietary protocols described above.

Measurements

BMI was calculated using standard formula: weight in kilograms divided by height in meters squared (kg/m^2). Measurements were taken using calibrated digital scales and stadiometers under standardized conditions and monitored by a consultant physiotherapist.

Statistical Analysis

Analysis of covariance (ANCOVA) was employed to compare post-test BMI scores between the groups while controlling for pre-test scores. Significant differences were further explored using Scheffé's post-hoc test. A significance level of $p < .05$ was used for all analyses.

Results

A one-way analysis of covariance (ANCOVA) was conducted to compare the efficacy of three interventions Yoga, Diet, and their combination (Yoga + Diet) on Body Mass Index (BMI), controlling for pre-test scores. Descriptive statistics for pre-test, post-test, and adjusted post-test BMI scores are shown in Table 1.

Descriptive Statistics and ANCOVA Results

Mean pre-test BMI scores for the yoga group ($M = 31.94$), diet group ($M = 30.81$), and yoga & diet group ($M = 28.88$) did not differ significantly, $F(2, 18) = 0.45$, $p > .05$. Similarly, post-test scores were not significantly different across the groups, $F(2, 18) = 0.95$, $p > .05$.

However, after adjusting for pre-test scores, a significant difference was found in post-test BMI scores among the three groups, $F(2, 17) = 17.70$, $p < .05$, partial $\eta^2 = .68$, indicating a large effect size. The adjusted means were 29.90 for the yoga group, 30.49 for the diet group, and 28.88 for the combined yoga and diet group (see Table 1).

Mean Gain Scores

The yoga & diet group showed the greatest reduction in BMI (mean gain = -1.58), followed by the yoga group (-0.72), and the diet group (-0.07), suggesting the combination intervention was the most effective.

Post-Hoc Analysis

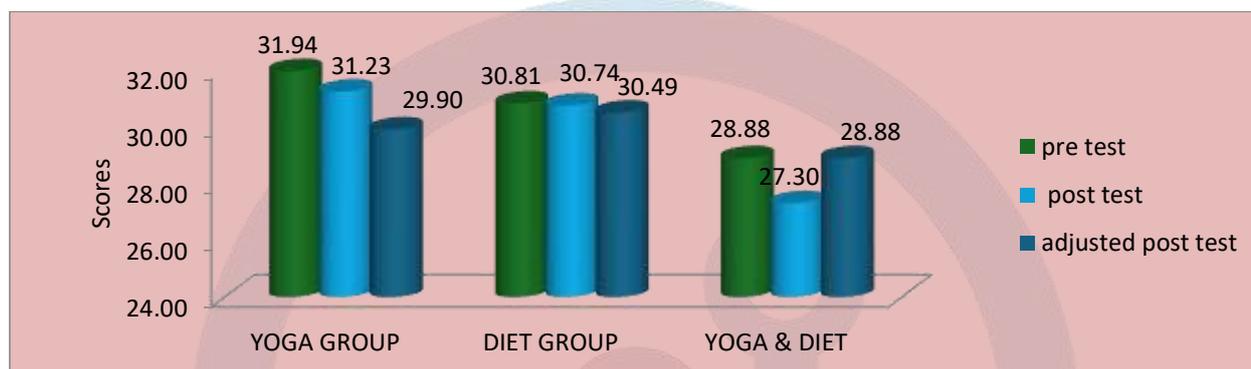
To explore specific group differences, Scheffé's post-hoc test was conducted. Results indicated a statistically significant difference between the yoga & diet group and both the yoga-only group (mean difference = -1.01) and the diet-only group (mean difference = -1.60), both exceeding the critical difference ($CD = 0.62$) at the 5% level. Nevertheless, the difference between the yoga-only and diet-only groups (-0.59) was not statistically significant (see Table 2).

Table 1: ANCOVA Summary and Descriptive Statistics for BMI Across Groups

Test	YOGA GROUP	DIET GROUP	YOGA & DIET	sv	ss	df	MS	F	
Pre test	31.94	30.81	28.88	between	33.50	2.00	16.75	0.45	
				within	666.70	18.00	37.04		
Post test	31.23	30.74	27.30	between	63.99	2.00	32.00	0.95	
				within	607.37	18.00	33.74		
Adjusted	29.90	30.49	28.88	between	8.96	2.00	4.48	17.70	2.64
				within	4.30	17.00	0.25		
Mean gain	-0.72	-0.07	-1.58						

Table 2: Scheffé's Post-Hoc Comparison of Adjusted BMI Scores

Comparison	Mean Difference	CD (5%)	Significant
Yoga vs Diet	-0.59	0.62	No
Yoga vs Yoga & Diet	-1.01	0.62	Yes
Diet vs Yoga & Diet	-1.60	0.62	Yes

**Bar Chart:** Comparison of three intervention groups

Discussion

Nonalcoholic fatty liver disease (NAFLD) is a foremost cause of widespread liver disease with a prevalence of 25–30%.⁶ In the last couple of decades, NAFLD has emerged as the most common liver disease in adults.⁷ NAFLD disproportionately affects persons with obesity and diabetes.⁸ The BMI is correlated with insulin resistance, visceral fat, fasting blood sugar, and musculoskeletal mass among type 2 diabetes mellites patients with peripheral neuropathy.⁹ NAFLD is now the leading indication for liver transplant among women. The management of women with NAFLD should also consider their unique risk profiles, including hormonal milieu and reproductive factors.¹⁰ The present study analysed the individual and combined effects of yoga and dietary intervention on Body Mass Index (BMI) among middle aged women. While no statistically significant differences were found in pre-test or post-test BMI values across the three groups, the adjusted post-test BMI scores, controlling for initial differences, revealed significant group differences. This suggests that the interventions produced meaningful changes when pre-existing variation was accounted for.

Most notably, the combination of yoga and diet led to the greatest reduction in BMI, as evidenced by both the mean gain scores and the results of Scheffé's post-hoc test. Participants in the combined group showed a statistically significant improvement in BMI compared to those in the yoga-only and diet-only groups. These findings align with existing research suggesting that multi-modal lifestyle interventions tend to be more effective than single-mode approaches in managing weight and improving metabolic health.

Even though the yoga-only group showed modest improvements in BMI, the difference was not statistically significant when compared to the diet-only group. This could suggest that short-term intervention in either yoga or diet alone may not be adequate to produce significant BMI reduction. Though, the reciprocal effect observed in the combined group indicates that lifestyle modifications may work greatest when integrated. The mechanism behind this enhanced effectiveness may be attributed to both behavioural and physiological influences. Yoga practices have been revealed to regulate and reduce stress and improve

hormonal balance, which may indirectly support weight management, while dietary changes directly impact caloric intake and metabolic processes. Together, these components may create a more sustainable and holistic approach to reducing BMI.

Limitations

There are some limitations to consider. The sample size was relatively small, which may have limited the statistical power to detect smaller differences between the yoga and diet groups. The duration of the intervention may also have influenced the results; longer-term interventions might yield more pronounced outcomes. Additionally, the study relied on BMI as the sole measure of health improvement. Future studies should consider including additional markers such as body fat percentage, waist-to-hip ratio, or biochemical indicators.

Conclusion

Yoga therapy thus could be considered as an effective therapeutic modality.¹¹ Baseline BMI influences the likelihood of NAFLD determination.¹² In conclusion, the findings of this study suggest that a combined yoga and dietary intervention is more effective in reducing BMI than either intervention alone. This reduction in BMI holds important clinical implications for the management and prevention of metabolic dysfunction-associated fatty liver disease (MAFLD), where weight reduction remains a primary therapeutic goal. The combined effect observed in the yoga and diet group supports the integration of mind-body practices and nutritional therapy as a comprehensive, non-pharmacological approach to improving metabolic health. These results contribute to the growing body of evidence that multidimensional lifestyle interventions offer the greatest benefit for individuals at risk of metabolic diseases. These results underscore the importance of integrated health approaches in managing weight and promoting overall well-being. Future research with larger sample sizes, longer intervention durations, and direct measurement of liver health (e.g., ultrasound or liver enzyme levels) is recommended to establish causal links between lifestyle changes, BMI reduction, and MAFLD progression.

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