TPM Vol. 32, No. S8, 2025
ISSN: 1972-6325
https://www.tpmap.org/

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RENAL FUNCTION MODULATION IN PATIENTS WITH METABOLIC SYNDROME: CAN YOGA AS AN ADJUVANT THERAPY HELP

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Abstract

Background: Metabolic syndrome (MetS) increases the risk of renal dysfunction through mechanisms such as oxidative stress, endothelial injury, and low-grade inflammation. Despite pharmacotherapy, Decline in renal function remains a concern. Yoga, an integrative mind–body practice, has shown potential to modulate systemic inflammation and autonomic balance, thereby improving renal outcomes.

Objective: To evaluate the effect of Adjuvant Yoga Therapy (AYT) on renal function markers in patients with MetS when combined with Standard Medical Management (SMM).

Methods: In this open- label randomized controlled trial, 116 adults with MetS were allocated to SMM plus AYT (n=58) and SMM alone (n=58) for six months. Primary outcomes were change in serum urea and creatinine, measured at baseline, three, and six months. Analysis used repeated measures ANOVA and independent t-tests.

Results: Urea levels significantly declined in the AYT group but remained unchanged in SMM. Creatinine decreased by 13.6% in AYT but increased by 7.3% in SMM. Significant group × time interactions were observed for both outcomes.

Conclusion: Adjuvant yoga therapy demonstrated renoprotective benefits by decreasing urea and creatinine levels in MetS patients, suggesting its utility as a safe, low-cost, culturally acceptable adjunct to standard care.

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ISSN: 1972-6325
https://www.tpmap.org/

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Keywords: Metabolic syndrome, Yoga, Renal function, Creatinine, open label randomized controlled trial

INTRODUCTION

Metabolic syndrome (MetS) is a clustering of cardio metabolic abnormalities, including central obesity, hypertension, insulin resistance, dyslipidaemia, and glucose intolerance. [1,2] While the primary focus of MetS research and management has been cardiovascular disease and type 2 diabetes, growing evidence indicates that the kidney is an equally important target organ.[3–5] Individuals with MetS are at heightened risk of chronic kidney disease (CKD), mediated through mechanisms such as endothelial dysfunction, glomerular hyper filtration, oxidative stress, and low-grade inflammation.[6–8] Subclinical alterations in renal markers such as urea and serum creatinine often precede overt nephropathy, making them valuable surrogate indicators for early risk assessment. Standard medical management (SMM) of MetS typically involves pharmacological treatment of hypertension, dyslipidaemia, and diabetes, along with lifestyle counselling. However, despite pharmacotherapy, the burden of renal decline continues to rise. Complementary approaches that target systemic inflammation, improve insulin sensitivity, and reduce sympathetic overdrive are therefore of clinical relevance.[6,9]

Yoga, a mind–body discipline integrating ***āsanas***, ***prāṇāyāma***, and relaxation techniques, has gained attention as a non-pharmacological adjunct.[8] Evidence indicates that yoga reduces oxidative stress, modulates the hypothalamic–pituitary–adrenal (HPA) axis, enhances autonomic balance, and improves renal hemodynamic.[10] Trials in patients with diabetes and hypertension have reported beneficial effects on micro albuminuria, glomerular filtration rate and serum creatinine, suggesting potential renoprotection.

The present randomized controlled trial was designed to investigate whether Adjuvant Yoga Therapy (AYT), when combined with SMM, confers additional benefits on renal function markers—specifically serum urea and creatinine—in patients with MetS.

METHODOLOGY

Study Design and Setting

This was a prospective, randomized controlled interventional trial conducted over six months at a tertiary care teaching hospital in Puducherry, within the Department of General Medicine at AVMC and the School of Yoga Therapy, Institute of Salutogenesis and Complementary Medicine (ISCM), SBV. Ethical approval was granted by the Institutional Ethics Committee (AVMC/IEC2019/015), and the study was registered prospectively with the Clinical Trial Registry of India (CTRI/2018/08/015514). All participants provided written informed consent, and the study adhered to the Declaration of Helsinki (2013 revision).

Study Population

Adults aged 30–60 years diagnosed with metabolic syndrome (MetS) according to International Diabetes Federation (IDF) criteria were eligible. Central obesity (waist circumference ≥90 cm in men or ≥80 cm in women for South Asians) plus two or more additional factors—elevated triglycerides (≥150 mg/dL) or treatment for dyslipidemia, reduced HDL cholesterol (<40 mg/dL in men, <50 mg/dL in women), hypertension (≥130/85 mmHg or antihypertensive therapy), or fasting plasma glucose ≥100 mg/dL/known type 2 diabetes—were required. Exclusion criteria included known chronic kidney disease, acute renal failure, hepatic dysfunction, pregnancy or lactation, severe psychiatric or musculoskeletal limitations, and current structured yoga/exercise practice.

Sample Size and Randomization

Sample size was calculated using a two-sample mean comparison with $\alpha = 0.05$ and 80% power, yielding 48 participants per group. Allowing for 20% attrition, 58 were recruited per arm (116). Eight participants withdrew (3 from control, 5 from intervention). Randomization employed a computer-generated block sequence (block sizes 4 and 6) with allocation concealment using sequentially numbered opaque envelopes.[11] Two groups were defined: Group 1 received Standard Medical Management (SMM) plus Adjuvant Yoga Therapy (AYT), and Group 2 received SMM alone. Due to the nature of the intervention, blinding of participants was not feasible, but laboratory staff and statisticians remained blinded.

Interventions

SMM included guideline-based pharmacological management of hypertension, diabetes, and dyslipidemia, as well as dietary counselling and advice on ≥150 minutes/week of moderate physical activity. AYT participants additionally undertook a yoga therapy program validated by certified yoga therapists, integrative medicine experts comprising "**techniques to enhance experience of the life force" *pranayama*** and ***asanas*** "mindful static postures to cultivate body awareness" were listed in table-1. Sessions were supervised thrice-weekly supervision with daily home practice. Compliance was monitored with logbooks and weekly phone reinforcement.

Table- 1: Yoga therapy schedule for metabolic syndrome

• SookshamVyayama- Mainly for the abdomen, chest and hip
• Aruna suryanamaskar variation I– 3 rounds
• Ardhakati & Katichakrasana
• Trikonasana
• Vakrasana
• Bharatwaja asana
• Paschimottanasana
• Nava asana
• Pavanamukta Series (As eka & dwi padakriya and asana)
• Jatara Paravrithi
• Sarvanga asana & Viparitakarani
• Chandra Nadi Pranayama
• Nadi Shuddhi Pranayama
• Brahma Mudra
• Kavi (Sadanta) Pranayama
• Kaya kriya: dynamic body relaxation with • movements of lower, upper limbs and head and neck with breathing
• Spandha Nishpandha Kriya: self-directed • complete tensing of whole body followed by its instant relaxation
• Shavasana with Savithri pranayama Breathing In for 4 secs, hold in 2 secs, • breathing out for 2 secs, hold out for 2 secs
• Shavasana with Pranava pranayama: Breathing in and then breathing out with the sounds of aaa... uuu… and mmm…
• Shavasana with deep inhalation & exhalation
Total duration = 1 hour 35 minutes • Techniques were delivered through a structured, progressive loading approach, whereby practices were incrementally introduced and reinforced in successive sessions
• **Weeks 1–11**- During this phase, all yogic techniques were gradually introduced to participants enrolled in the AYT
• **Weeks 11–36**- Following the introduction, all practices were systematically reinforced and administered throughout this period to ensure familiarity and consistency of practice

- **Week 37-** At the end of 36 weeks, participant feedback was obtained to evaluate the intervention and gather insights on adherence, feasibility, and perceived benefits.
- **Weeks 38–72-** all previously taught practices were continued, to enhance long-term applicability and sustainability of the practices.

Outcome Measures

Primary outcomes were serum urea and creatinine measured at baseline, three months, and six months. Secondary outcomes included percentage changes in renal biomarkers and time × group interaction effects using repeated measures ANOVA.

Data Collection and Analysis

Fasting blood samples were analysed for blood urea (urease–glutamate dehydrogenase method) and serum creatinine (modified Jaffe method) on an automated analyser (Erba XL-640). Anthropometry and blood pressure were measured using standardized protocols. Data were analysed using SPSS v21. Continuous variables were expressed as mean ± SD, categorical variables as frequencies. Independent t-tests assessed between-group differences, repeated measures ANOVA evaluated within-group changes and interaction effects, and Δ% changes were calculated. A p-value <0.05 was considered significant.

Ethical Considerations

Confidentiality was ensured, and participants could withdraw at any stage. After study completion, yoga training was offered to the SMM.

In this randomized comparison between Adjuvant Yoga Therapy (AYT) and Standard Medical Management (SMM) for patients with metabolic syndrome, significant differences were observed in biochemical markers over time. Baseline urea levels were higher in the AYT group, but both groups' demonstrated reductions post-intervention. Repeated measures ANOVA showed a significant within-group reduction in urea for AYT ($p = 0.003$), while no significant change was seen in SMM ($p = 0.226$). Between-group differences in urea remained significant across all time points, with an interaction effect ($p = 0.03$), indicating differing trajectories over time.

Creatinine levels showed divergent trends. AYT demonstrated a significant decline (–13.6%, $p < 0.001$), while SMM exhibited a significant increase (+7.3%, $p < 0.001$). Between-group differences were highly significant at interim and post-intervention ($p < 0.001$), with a strong interaction effect ($p < 0.001$), highlighting that yoga therapy conferred renal protective benefits compared with standard care. These findings suggest that integrating yoga therapy as an adjuvant may positively modulate renal function markers and contribute to improved metabolic outcomes in patients with metabolic syndrome.

RESULTS

Table 2. Baseline and Follow-up Values (Mean ± SD)

Variable	Time point	AYT (Group 1, Mean ± SD)	SMM (Group 2, Mean ± SD)	p-value (Between Groups)
Urea (mg/dL)	Pre	33.5 ± 5.0	30.8 ± 5.3	0.008
	Interim	31.6 ± 4.1	29.7 ± 5.6	**0.041**
	Post	31.9 ± 4.2	29.1 ± 5.3	**0.003**
Creatinine (mg/dL)	Pre	1.10 ± 0.20	1.10 ± 0.20	0.721
	Interim	1.03 ± 0.16	1.12 ± 0.16	0.008
	Post	0.95 ± 0.15	1.18 ± 0.14	**<0.001**

Table 3. Within-Group Changes (Repeated Measures ANOVA)

Variable	AYT p-value	SMM (Group 2) p-value
Urea	0.003 (significant)	0.226 (ns)
Creatinine	**<0.001 (significant ↓)**	**<0.001 (significant ↑)**

Table 4. Delta Percentage Change (Pre → Post) and Interaction

Variable	Δ% AYT (Group 1)	Δ% SMM (Group 2)	Interaction p-value (Time × Group)
Urea	-4.8%	-5.5%	0.03
Creatinine	-13.6%	+7.3%	<0.001

DISCUSSION

In this randomized trial, adjuvant yoga therapy (AYT) in patients with metabolic syndrome (MetS) conferred significant renal benefits compared with standard medical management (SMM). Urea levels declined significantly

in the AYT group ($p = 0.003$) but remained unchanged in SMM ($p = 0.226$). More strikingly, creatinine decreased by 13.6% in AYT but increased by 7.3% in SMM, with highly significant between-group differences ($p < 0.001$). These findings highlight that yoga beneficially influenced renal trajectories beyond usual care, suggesting a role in slowing early renal dysfunction, an important consideration given the elevated risk of diabetes- and hypertension-related kidney disease.

Our results align with prior work demonstrating yoga's influence on biochemical and inflammatory pathways relevant to renal protection. Balaji et al. showed that four months of yoga in type 2 diabetes significantly reduced glucose, HbA1c, urea, and creatinine[12]

Similarly, Pandey et al. reported that a six-month yoga program in CKD patients reduced blood pressure, urea, and creatinine while improving quality of life[13.] In MetS cohorts, yoga appears to exert renoprotective effects through systemic and inflammatory modulation. Yadav et al. demonstrated reductions in leptin, IL-6, and oxidative stress markers with increased adiponectin[14]. Yu et al. found that one year of yoga in centrally obese adults improved waist circumference, physical function, and ghrelin axis regulation[15]. Supriya et al. similarly showed favorable shifts in adipokines including leptin, chemerin, and adiponectin[16]. These mechanisms may underlie the creatinine stabilization observed in our trial.

Broader evidence supports yoga's systemic benefits. Cota e Souza et al. showed a 34.1% reduction in MetS prevalence with improvements in hs-CRP and adiposity indices[17], while meta-analyses by Chu et al. and Cramer et al. confirmed reductions in blood pressure, waist circumference, and triglycerides[18], [19]. Taken together, our study extends existing evidence by focusing specifically on renal biomarkers in MetS, an underexplored domain. The consistent improvements in urea and creatinine underscore yoga's potential as an adjunctive, low-cost, and culturally acceptable therapy to delay kidney complications. Future trials incorporating endpoints such as eGFR and albuminuria are warranted. This was an **open-label study**, and hence, a potential for **observer bias** existed in the evaluation of outcomes.

However, this limitation was **mitigated by employing a blinded outcome assessor**, ensuring objectivity in data collection and minimizing assessment bias.

CONCLUSION

Adjuvant yoga therapy significantly improved renal function markers in patients with metabolic syndrome (MetS). Yoga represents a safe, low-cost, and culturally acceptable adjunct that may help delay chronic kidney disease (CKD) progression when integrated with standard medical care. However, larger and longer-term studies incorporating metabolic and inflammatory biomarkers are warranted to validate its translational potential beyond conventional renal indices.

Conflict of Interest

None declared.

Acknowledgements

We thank the Departments of General Medicine and CYS, AVMC & ISCM, SBV, Puducherry, for their support.

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