International Journal of Traditional and Integrative Health Sciences
An Official Publication of Sushruta Academic Publishing House
Peer Reviewed | Volume 1, Issue 2 (2026) | ISSN: [to be assigned] | DOI: [to be assigned]

REVIEW ARTICLE

Role of Yoga in the Prevention of Lifestyle-Related Disorders: A Critical Review of Clinical Evidence and Underlying Mechanisms

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Abstract
Lifestyle-related non-communicable diseases dominate global mortality, and interventions that address several behavioural risk factors simultaneously are a public health priority. Objective: To critically evaluate the clinical evidence and proposed physiological mechanisms concerning Yoga in the prevention and risk reduction of lifestyle-related disorders. Methods: A critical narrative review of randomized trials, systematic reviews, meta-analyses and mechanistic studies identified through PubMed, Scopus, the Cochrane Library and Google Scholar, read alongside classical Yoga and Ayurvedic sources; every cited clinical publication was verified against its PubMed record. Findings: Meta-analyses of randomized trials report modest improvements in blood pressure, body mass index, waist circumference, fasting glucose, glycated haemoglobin and lipids, chiefly against non-active comparators and with low to very low certainty of evidence. Evidence for prevention of disease incidence, as distinct from risk-factor modification or management of established disease, is lacking; almost all trials enrol populations with existing risk factors or diagnosed conditions. The proposed mechanisms — autonomic regulation, hypothalamic–pituitary–adrenal modulation, reduced inflammatory activity, and metabolic and behavioural self-regulation — are biologically plausible but rest largely on surrogate markers and heterogeneous protocols. Conclusion: Yoga appears to be a safe, accessible adjunct for modifying selected lifestyle-related risk factors. Claims of primary prevention of specific disorders are not yet supported; standardized interventions, active comparators and long-term trials with clinically meaningful endpoints are required.

Keywords: *Yoga*; Lifestyle-related disorders; Preventive medicine; *Swasthavritta*; Stress regulation; Metabolic health; Lifestyle modification

Introduction
Non-communicable diseases account for the largest share of global mortality; the World Health Organization attributes at least 43 million deaths in 2021, roughly three quarters of all non-pandemic deaths, to this group of conditions.[1] Most of these deaths trace to a small cluster of cardiometabolic disorders — obesity, type 2 diabetes mellitus, hypertension and atherosclerotic cardiovascular disease — driven by modifiable behaviour and environment: nine such factors together explained more than 90% of the population risk of a first myocardial infarction in the INTERHEART study.[2] The burden is now concentrated in low- and middle-income settings; the ICMR-INDIAB national survey in India documented a substantial and geographically uneven prevalence of diabetes, prediabetes, obesity, hypertension and dyslipidemia.[3]

Public health responses have therefore moved beyond single-risk-factor models toward interventions that address physical activity, diet, sleep and psychological stress together. Yoga is one candidate. As practiced today it combines physical postures (*Asana*), regulated breathing (*Pranayama*), meditation (*Dhyana*) and ethical-behavioural observances (*Yama* and *Niyama*) — a single, low-cost, culturally acceptable practice engaging several risk pathways at once. Its traditional home in Ayurvedic preventive healthcare (*Swasthavritta*), with structured daily and seasonal regimens (*Dinacharya*, *Ritucharya*), reinforces this framing, although the two systems are historically distinct and not interchangeable.

Whether conceptual attractiveness survives contact with clinical evidence is a separate question. Enthusiasm has outpaced methodological rigour in parts of this literature, and preventive claims are frequently inferred from studies that measured something else — symptom control, risk-factor levels, or short-term biomarker change in populations that already have disease. This article reviews the clinical evidence and proposed mechanisms with an explicitly critical orientation. As a narrative rather than systematic review, its purpose is to

weigh what the best published evidence supports, what it does not, and where uncertainty remains.

Classical Foundations of Yoga and Preventive Healthcare

Classical Yoga is articulated most influentially in *Patanjali's Yoga Sutra*, which orders practice through eight limbs: ethical restraints (*Yama*), observances (*Niyama*), posture (*Asana*), breath regulation (*Pranayama*), sense withdrawal (*Pratyahara*), concentration (*Dharana*), meditation (*Dhyana*) and absorption (*Samadhi*).[4] Two features matter for a modern preventive reading. *Asana* receives comparatively little elaboration: the sutras require only that a posture be steady and comfortable (*Sthira-Sukham*) before breath and attention practices proceed (2.46–2.49). The framework is behavioural before it is physical restraint, observance and discipline of attention precede the psychophysiological limbs. The later *Haṭha* tradition developed postural and breath techniques in greater detail, with the second chapter of the *Haṭha Yoga Pradipika* devoted largely to *Pranayama*.[5]

This behavioural emphasis is directly relevant to prevention. The *Bhagavad Gita* frames *Yoga* as moderation: the practice is not for one who eats too much or too little, sleeps too much or too little, and regulation of eating, recreation, work and sleep is linked with freedom from suffering.[6] Ayurvedic preventive medicine works in a parallel register: *Charaka's Sutrasthana* devotes a chapter to disorders following suppression of natural urges,[7] while *Sushruta* defines the healthy person (*Svastha*) as one whose doshas, digestive fire, tissues and eliminations are balanced and whose self, senses and mind are content.[8] Daily and seasonal regimens translate this into routines of sleep, food, activity and hygiene.

These positions anticipate modern ideas — behavioural self-regulation, sleep regularity, embodied awareness — but are philosophical claims of a different kind from biomedical mechanisms. Analogies between dosha balance and metabolic homeostasis may be heuristically useful, yet remain interpretive rather than demonstrated correspondences; the sections that follow keep that distinction explicit.

Clinical Evidence for Yoga in Lifestyle-Related Disorders

The evidence base is dominated by randomized trials of 8–24 weeks in populations with established risk factors or diagnosed disease, synthesized in several meta-analyses. Three features recur across them: small samples, non-active comparators and low certainty of evidence. Table 1 summarizes representative studies; the subsections below interpret them condition by condition.

Table 1. Clinical evidence on Yoga-based interventions for lifestyle-related disorders

Disorder / risk factor	Design	Population (n)	Yoga intervention and duration	Reported outcomes	Major limitations
Obesity / weight[9]	Systematic review and meta-analysis of 30 RCTs	2,173 adults	Heterogeneous asana-based protocols; duration trial-dependent	No overall effect on weight, BMI, body fat or waist circumference; BMI effect in overweight/obese subgroup vs usual care (SMD −0.99)	Not robust to selection bias; publication bias possible
Type 2 diabetes (management)[11]	Meta-analysis of 23 controlled studies	2,473 adults with T2DM	Yoga vs control; ≥8 weeks	HbA1c, fasting and postprandial glucose, lipids, BP, BMI, cortisol improved	Mean 41% of methodological quality criteria met; heterogeneous protocols
Type 2 diabetes (management)[12]	Meta-analysis of 12 RCTs	864 adults with T2DM	Yoga vs control; duration not reported	Fasting glucose −23.7 mg/dL; HbA1c −0.47%; lipids improved	Heterogeneity up to 82%; limited trial quality
Prediabetes (prevention-oriented)[13]	Pilot RCT	41 adults with elevated fasting glucose	Yoga vs walking; 8 weeks	Greater reductions in weight, waist circumference and BMI; no between-group glycemic difference	Small sample; pilot design
Prediabetes (prevention-oriented)[14]	RCT	29 adults with prediabetes	Community-based yoga; 3 months	Reduced malondialdehyde, BMI, waist circumference, systolic BP and fasting glucose; HbA1c unchanged	Very small sample; wait-list control
Hypertension[15]	Meta-analysis of 7 RCTs	452 patients	Yoga ≥8 weeks vs usual care or exercise	SBP −9.65 / DBP −7.22 mmHg vs usual care; no effect vs exercise	Very low-quality evidence; heterogeneity >90%; more adverse events with yoga
Hypertension[16]	Updated meta-analysis of 30 RCTs	2,283 participants	Yoga vs any control	SBP −7.95 / DBP −4.93 mmHg vs waitlist; no significant SBP effect vs active control	Very low certainty; high heterogeneity
Cardiovascular risk factors[17]	Meta-analysis of 44 RCTs	3,168 participants	Asana-based yoga vs usual care	Improvements in BP, heart rate, waist circumference, lipids, HbA1c, insulin resistance	High or unclear risk of bias in most trials

Metabolic syndrome[19]	Meta-analysis of 7 trials	794 participants	Yoga vs usual care	Waist circumference and SBP improved; no effect on resolution of metabolic syndrome	Effects not robust to selection bias
Workplace stress[30]	RCT	48 university employees	Dru Yoga, 60 min/week; 6 weeks	Improved mood and well-being (7 of 8 measures)	Small sample; wait-list control; self-report outcomes
Sleep quality (women)[23]	Meta-analysis of 19 RCTs	1,832 women with sleep problems	Heterogeneous yoga vs control	Overall sleep SMD −0.33; PSQI −0.54; insomnia severity unchanged	Subjective outcomes dominate; non-active comparators
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Yoga and Obesity

The most informative synthesis, a meta-analysis of 30 randomized trials (2,173 participants), found no overall effect of Yoga on body weight, body mass index (BMI), body fat percentage or waist circumference; a benefit for BMI appeared only in the subgroup of overweight or obese participants compared with usual care, was not robust to correction for selection bias, and was accompanied by possible publication bias.[9] Comparisons with exercise complicate interpretation, since Yoga is generally less energetically intensive; a narrative review of comparison studies concluded that Yoga appears broadly comparable to exercise across several health domains while acknowledging pervasive methodological weaknesses.[10] Short-term trials of this kind cannot address long-term obesity prevention, which has not been tested.

Yoga and Type 2 Diabetes Mellitus

For glycemic outcomes in diagnosed disease, a meta-analysis of 23 controlled studies (2,473 adults with type 2 diabetes) reported standardized improvements in HbA1c (0.36), fasting blood glucose (0.58) and postprandial glucose (0.40) favouring Yoga, alongside better lipids, blood pressure and BMI; the included studies met on average only 41% of methodological quality criteria.[11] A second meta-analysis of 12 randomized trials (864 patients) reported pooled reductions in fasting glucose (−23.7 mg/dL) and HbA1c (−0.47%), with heterogeneity of 82% for both outcomes.[12] These are management data. Prevention-oriented evidence is far thinner: a pilot randomized trial in 41 Indian adults with elevated fasting glucose found greater reductions in weight, waist circumference and BMI with Yoga than with walking, but no between-group glycemic differences,[13] and a three-month trial in 29 people with prediabetes reported improved fasting glucose, BMI, systolic pressure and

oxidative-stress markers against wait-list control, with no change in HbA1c.[14] No completed trial has demonstrated reduced diabetes incidence.

Yoga and Hypertension

Two generations of meta-analyses frame this field. The earlier synthesis of seven randomized trials (452 patients) reported systolic and diastolic reductions of 9.65 and 7.22 mmHg versus usual care, but graded the evidence very low quality, documented heterogeneity above 90%, noted more adverse events during Yoga than usual care, and found no benefit versus exercise [15]. The 2025 update (30 trials, 2,283 participants) reported smaller pooled effects against waitlist controls (−7.95 and −4.93 mmHg), no significant systolic effect against active controls, and again very low certainty with high heterogeneity.[16] Effects cluster where comparators are inert; active-control designs, which isolate Yoga-specific effects, show attenuated or non-significant differences. Reductions of the magnitude reported against waitlists would be clinically meaningful if confirmed, but current evidence does not support claims of hypertension prevention.

Yoga and Cardiovascular Health

The broadest synthesis, covering 44 randomized trials (3,168 participants), reported improvements across multiple risk markers — blood pressure, heart rate, waist circumference, total and low-density lipoprotein cholesterol, triglycerides, HbA1c and insulin resistance — versus no intervention.[17] A second meta-analysis found consistent improvements in BMI, blood pressure and lipids versus non-exercise controls, with no significant differences between Yoga and exercise.[18] For metabolic syndrome specifically, seven trials (794 participants) showed benefit only for waist circumference and systolic pressure versus usual care, no effect on resolution of the syndrome, and effects that were not robust to selection bias.[19] All of these are surrogate outcomes. On autonomic function, a comprehensive review reported increased heart rate variability and vagal predominance during Yoga practices[20]; during-practice values, however, largely reflect slowed respiration and cannot be read as improved resting cardiac autonomic tone, let alone as evidence of fewer cardiovascular events.

Yoga, Stress and Sleep

Stress-related outcomes are the most consistent in this literature, though most measures are subjective. A meta-analysis of 42 randomized trials found that Yoga-inclusive practices, compared with active controls, were associated with lower evening and waking cortisol, reduced ambulatory systolic pressure and lower resting heart rate, alongside mixed heart-rate-variability findings.[21] For anxiety, eight randomized trials showed small short-term effects versus no treatment but no benefit in formally diagnosed anxiety disorders — a distinction often lost in secondary reporting.[22] In women with sleep problems, a meta-analysis of 19 trials (1,832 participants) found modest overall improvement (standardized mean difference −0.33), driven by Pittsburgh Sleep Quality Index comparisons against non-active controls, with null effects on insomnia severity and in clinically defined subgroups.[23] The preventive relevance is indirect but grounded: pooled cross-sectional analyses of more than 630,000 children and adults associate short sleep duration with obesity (odds ratio about 1.55 in adults).[24] Whether Yoga-induced improvements in stress and sleep translate into reduced cardiometabolic incidence has not been demonstrated.

Underlying Physiological and Psychological Mechanisms

Several pathways have been proposed to connect Yoga practice with cardiometabolic risk reduction. Their status differs: some rest on replicated measurements in controlled settings, others on small studies or theoretical extension. Table 2 summarizes the main claims with their evidentiary basis; the treatment below is correspondingly cautious.

Autonomic Nervous System Regulation

The best-studied pathway concerns autonomic regulation. Voluntary slowing of respiration below roughly ten breaths per minute increases heart rate variability and respiratory sinus arrhythmia, with concurrent changes in cortical and subcortical activity documented in electroencephalographic and imaging studies.[25] Yoga practices reliably slow respiration during sessions, and reviews report increased heart rate variability and vagal predominance during practice.[20] Two qualifications matter. First, variability measured during slow breathing largely reflects the breathing pattern itself, so during-practice values cannot be equated with improved resting autonomic tone. Second, heart rate variability is an aggregate index influenced by

age, fitness and respiration; treating it as a direct measure of vagal activity overstates its resolution. Resting and ambulatory effects of sustained practice remain incompletely characterized.

Table 2. Clinical evidence on Yoga-based interventions for lifestyle-related disorders

Physiological pathway	Yoga component	Proposed mechanism	Supporting evidence	Limitations and uncertainty
Autonomic regulation	Pranayama; slow breathing; relaxation	Shift toward parasympathetic predominance; increased heart rate variability	Increased HRV and respiratory sinus arrhythmia during slow breathing;[25] vagal predominance during practices [20]	During-practice HRV largely reflects slowed respiration; HRV is not a direct vagal measure
HPA axis regulation	Meditation; relaxation; savasana	Reduced cortisol output and stress reactivity	Lower waking and evening cortisol vs active controls in meta-analysis[21]	Heterogeneous sampling protocols; inconsistent findings across trials
Inflammation and oxidative stress	Combined practice	Reduced CRP, IL-6, TNF-α; reduced lipid peroxidation	11 of 15 studies improved ≥1 biomarker; dose effect >1,000 min;[28] reduced malondialdehyde in prediabetes;[14] narrative support[29]	Small heterogeneous trials; associations, not proven causal chains
Metabolic regulation	Asana practice; behavioural change	Improved insulin sensitivity, glycemia and lipids via activity and stress pathways	Glycemic and lipid improvements in meta-analyses[11,12,17]	Effects attenuate vs exercise comparators;[18] surrogate endpoints only
Psychological and behavioural self-regulation	Dhyana; Yama/Niyama; interoceptive awareness	Improved emotion regulation, sleep and adherence to healthier behaviours	Self-regulation framework;[27] yoga > metabolically matched walking for mood with GABA correlations;[26] short sleep–obesity association[24]	Models largely theoretical; small single-centre neuroimaging studies
Autonomic regulation	Pranayama; slow breathing; relaxation	Shift toward parasympathetic predominance; increased heart rate variability	Increased HRV and respiratory sinus arrhythmia during slow breathing[25]; vagal predominance during practices[20]	During-practice HRV largely reflects slowed respiration; HRV is not a direct vagal measure

Hypothalamic–Pituitary–Adrenal Axis

Stress physiology provides a second candidate pathway. In the meta-analysis cited above, Yoga-inclusive interventions were associated with lower evening and waking cortisol and reduced ambulatory systolic pressure against active controls, interpreted as improved regulation of the hypothalamic–pituitary–adrenal axis .[21] The finding is not uniform: cortisol sampling protocols vary in matrix, timing and number of days, single-day estimates are noisy, and several trials report no change. Cortisol results are best viewed as directionally suggestive rather than established.

Inflammation and Oxidative Stress

A systematic review of 15 studies found that 11 reported improvements in at least one inflammatory biomarker — chiefly C-reactive protein, interleukin-6 or tumour necrosis factor-α — with higher total practice dose (more than 1,000 minutes) associated with larger effects[28]; narrative syntheses reach similar conclusions while noting methodological caveats.[29] In prediabetes, one randomized trial reported reduced malondialdehyde with Yoga.[14] These are associations observed largely in small, heterogeneous trials; they demonstrate biological activity of the practice, not a proven causal chain from reduced inflammation to fewer cardiometabolic events.

Metabolic Regulation

Metabolic effects are plausible through increased physical activity, improved insulin sensitivity and reduced stress-related eating, and are consistent with the glycemic and lipid changes reported in meta-analyses of trials in diabetes and mixed populations.[11,12,17] Effects attenuate against exercise comparators[18], suggesting that part of the metabolic signal reflects energy expenditure and musculoskeletal activity rather than Yoga-specific processes.

Psychological and Behavioural Mechanisms

A systems framework proposes that Yoga operates through interacting top-down processes (attention, emotion regulation) and bottom-up interoceptive processes.[27] Direct human evidence includes a randomized trial in which twelve weeks of Yoga improved mood and reduced anxiety more than metabolically matched walking, with changes correlating with thalamic γ-aminobutyric acid levels[26]— intriguing but small and single-centre. Behaviourally, better sleep and lower perceived stress could plausibly reduce downstream risk, given the short-sleep–obesity link.[24] The relative contributions of these pathways, and their interactions, are not established; Table 2 treats them as proposed, not proven.

Yoga as a Component of Preventive Healthcare

Whatever its eventual preventive credentials, Yoga has practical advantages for population-level implementation: it requires minimal equipment, adapts to different fitness levels, can be delivered in groups and carries high cultural acceptability in South Asia and

growing acceptability elsewhere. Randomized evidence in real-world settings is beginning to accumulate; a six-week workplace trial in university employees reported improved mood and resilience to stress relative to wait-list control.[30] Plausible delivery channels include workplace wellness programmes, educational institutions, community and primary care settings, and structured lifestyle-modification programmes.

Implementation raises specific requirements. Instructor qualification and standardized training matter because intervention fidelity is rarely verified in trials yet almost certainly shapes outcomes. Safety is generally favourable — a meta-analysis of randomized trials found adverse-event rates comparable to exercise and usual care, though minor events were more frequent than with health education[31]— but practice still requires adaptation for older adults, pregnant women and people with musculoskeletal or cardiovascular comorbidity. Adherence needs explicit design through home-practice support and follow-up. Most importantly, Yoga should be positioned as a complement to established preventive measures — physical activity guidance, dietary counselling, tobacco control, screening and evidence-based medical care — not as a substitute; overpromising risks therapeutic substitution, particularly where access to conventional care is limited.

Methodological Limitations and Research Gaps

Interpretation of this literature must contend with recurrent methodological weaknesses, summarized in Table 3. Sample sizes are typically small and durations short, most commonly 8–24 weeks. Protocols range from classical lineages to modern hybrids, with inconsistent reporting of session frequency, intensity and home practice, and little verification of adherence. Blinding of participants and instructors is inherently impracticable, and outcome assessors are frequently unblinded. Control conditions range from waitlist to exercise, which changes what a Yoga effect represents. Recruitment of health-motivated volunteers introduces selection bias and limits generalizability; follow-up is rarely long; outcome measures vary across trials and complicate pooling; and adverse events are often under-reported.

A conceptual limitation deserves separate emphasis. Most trials evaluate Yoga as adjunctive management in populations that already have disease. Such trials can support claims about risk-factor modification and symptom control, but not about prevention, which requires incident-disease endpoints in initially disease-free populations followed prospectively; the few prevention-oriented studies are small pilots with intermediate endpoints.[13,14] Reading management evidence as prevention evidence is the most common overstatement in this field.

Table 3. Methodological challenges and recommendations for future Yoga research

Research limitation	Implications for interpretation	Recommended methodological improvement
Small sample sizes	Imprecise estimates; spurious findings	Multicentre collaboration; pre-registered power calculations
Non-active comparators	Inflates apparent specificity of Yoga effects	Active, dose-matched control groups (e.g., exercise)
Heterogeneous protocols	Unclear which components drive outcomes	Component-defined, standardized manuals with fidelity monitoring
Short intervention durations	No evidence on maintenance or incidence	Follow-up of ≥12 months with maintenance phases
Blinding impracticable	Performance and detection bias	Blinded outcome assessors; objective endpoints
Inconsistent intensity, frequency and adherence reporting	Dose–response relationships uninterpretable	Standardized adherence metrics and objective tracking
Variable outcome measures (surrogates)	Limits pooling and clinical inference	Core outcome sets including clinically meaningful endpoints
Under-reported adverse events	Safety claims inadequately tested	Systematic adverse-event collection and reporting
Selection bias in health-motivated volunteers	Limited generalizability	Community-based recruitment; pragmatic designs
Conflation of management with prevention	Overstated preventive claims	Incidence-based endpoints in disease-free at-risk cohorts

Future Research Directions

Several priorities follow from these limitations. Intervention protocols should be standardized and component-defined, specifying Asana, Pranayama and meditation content, frequency, session length and home practice, with fidelity monitoring. Dose–response relationships deserve explicit evaluation, since total practice time appears to modify inflammatory effects.[28] Multicentre randomized trials with active comparators, objective physiological outcomes and at least twelve months of follow-up are needed, ideally enrolling high-risk but disease-free populations so that preventive rather than management effects can be isolated. Adherence measurement, systematic adverse-event

surveillance[31], pre-registration of trials, core outcome sets, and pragmatic studies of cost-effectiveness and implementation in primary care and community settings would connect efficacy questions to public health relevance.

Discussion

Viewed across conditions, the literature supports a consistent but modest pattern: Yoga produces small-to-moderate improvements in several cardiometabolic risk markers, most reliably against inactive comparators and less reliably against exercise or other active interventions. Where effects persist against active comparators — as for some cortisol and ambulatory blood-pressure findings — they are smaller and less certain. Variation is partly explicable: comparator intensity determines apparent specificity; population characteristics set the ceiling on measurable change; total practice dose differs widely; and delivery fidelity is seldom verified.

The distinction between these findings and prevention is the central interpretive issue. Risk-factor modification, adjunctive management and improvement in stress and sleep are documented to varying degrees. Primary prevention — averting disease onset — requires incidence endpoints in initially disease-free populations followed long enough for events to accrue, and almost no Yoga trial has attempted this. Improvements in HbA1c among people with diabetes are management outcomes; the small trials enrolling at-risk populations are suggestive but underpowered and brief.[13,14] Surrogate biomarkers add mechanistic texture rather than proof: a twelve-week reduction in C-reactive protein has no demonstrated translation into fewer clinical events.

The public health case for Yoga does not depend on unproven claims of incidence reduction. A safe, inexpensive, scalable practice with credible short-term effects on stress, sleep and selected cardiometabolic markers, and plausible behavioural spillovers, has value in preventive programmes on its own terms provided it complements rather than replaces physical activity guidance, nutrition, screening & medical care, & provided claims made to participants match the evidence.

Conclusion On present evidence, Yoga is best characterized as a safe and accessible practice capable of modifying selected lifestyle-related risk factors — blood pressure, glycemic markers, anthropometry, perceived stress and sleep quality — with effects that are modest, most consistent against inactive comparators and limited by methodological weakness. Evidence that Yoga prevents the onset of obesity, type 2 diabetes, hypertension or cardiovascular disease does not yet exist in the form of incidence-based trials. Its preventive potential therefore remains a hypothesis worth testing through standardized, well-described interventions, active comparators and long-term follow-up of at-risk but disease-free populations. Until such studies mature, Yoga's place in preventive healthcare is as a credible adjunct within broader lifestyle and medical care, not a stand-alone preventive strategy.

Financial Support and Sponsorship - Nil.

Conflicts of Interest- Not Any

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CITE THIS ARTICLE

Vancouver: Faruque M. Role of Yoga in the Prevention of Lifestyle-Related Disorders: A Critical Review of Clinical Evidence and Underlying Mechanisms. Int J Tradit Integr Health Sci. 2026;1(2): [37-44]