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Using Yogic Intervention Reduces Serum Lipids and Atherogenic Indices: A Comprehensive Study

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Abstract

Background. Optimal lipid regulation is a key determinant of cardiovascular health. Disturbances in lipid metabolism are associated with elevated cardiovascular risk. Yogic practices have demonstrated potential in modulating biochemical and cardiovascular parameters.

Objectives. The present study aimed to investigate the effect of a twelve-week structured yogic practice intervention on selected lipid profile parameters, namely total cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low-density lipoprotein (VLDL), cholesterol/HDL ratio, triglyceride/HDL ratio, LDL/HDL ratio, and non-HDL/HDL ratio among male college students.

Materials and Methods. Twenty-four students (aged 17–22 years) from Shyampahari Government Primary Teacher Training Institute, India, were randomly allocated into experimental (n = 12) and control (n = 12) groups. The intervention group practiced yoga for 1 hour/day, 6 days/week, over 12 weeks, while controls maintained routine activities. Venous blood samples were collected pre- and post-intervention and analyzed using an automated biochemical analyzer. Within-group differences were assessed using paired t-tests, and between-group comparisons employed independent t-tests. Statistical significance was set at $\alpha = 0.05$.

Results. The experimental group showed substantial reductions in total cholesterol ($p = .041$), triglycerides ($p = .015$), VLDL ($p = .021$), triglyceride/HDL ratio ($p = .003$), and non-HDL/HDL ratio ($p = .003$), alongside an increase in HDL ($p = .045$). Meanwhile, LDL ($p = .524$), LDL/HDL ($p = .149$), and cholesterol/HDL ratio ($p = .469$) remained unchanged. No significant changes were observed in the control group.

Conclusions. The findings indicate that a structured yogic program improves lipid metabolism and cardiovascular efficiency, supporting yoga as an effective non-pharmacological intervention for young adults.

Keywords: yoga, lipids, cardiovascular diseases, cholesterol, triglycerides, lipoproteins.

Introduction

In recent decades, the prevalence of lifestyle-related disorders, including dyslipidemia and cardiovascular diseases (CVD), has been steadily rising (Pirillo et al., 2021; Murray & Lopez, 1997). India bears one of the highest burdens of CVD worldwide, with a notable early onset compared to European populations, affecting individuals a decade earlier (Joshi et al., 2007; Xavier et al., 2008). Around 52% of Indians under 70 years of age succumb to CVD, in contrast to only 23% in Western countries (Sharma et al., 2022; Harikrishnan et al., 2014). The annual CVD-related death toll in India is projected to increase from 2.26 million to 4.77 million (Murray & Lopez, 1997). Dyslipidemia, a key modifiable risk factor for CVD, involves elevated total cholesterol, triglycerides, and LDL-C, alongside low HDL-C (Ali et al., 2023; Bamba & Rader, 2007). Occupational factors, including low physical activity, poor diet, and stress, contribute to dyslipidemia (Ali et al., 2023; Taye et al., 2024). Early screening and lipid management are crucial in reducing CVD morbidity and mortality, providing significant social value (Pikula et al., 2015).

Cholesterol is a vital lipophilic molecule crucial to human physiology, involved in processes such as biosynthesis, uptake, efflux, transport, storage, utilization, and excretion (Huff et al., 2023; Duan et al., 2022). Disruptions in cholesterol homeostasis are associated with various diseases, including cardiovascular conditions, neurodegenerative dis-

orders, and cancers (Duan et al., 2022). Dysregulated cholesterol levels contribute to one-third of ischemic heart disease cases, causing 2.6 million deaths and 29.7 million DALYs globally, emphasizing its major health impact (WHO, 2019). Numerous studies have explored the effects of yogic practices on lipid profiles. A meta-analysis of 53 studies, with 13,191 participants, demonstrated significant improvements in lipid parameters following yogic interventions (Ghazvineh et al., 2022).

Triglycerides are crucial in human health, with significant implications for cardiovascular and metabolic disorders. Epidemiological and genetic studies have identified triglyceride-rich lipoproteins (TRL) and their remnants as key contributors to atherosclerotic cardiovascular disease (ASCVD) (Laufs et al., 2020; Zhang et al., 2022). Hypertriglyceridemia, affecting 15-20% of the adult population, is particularly prevalent among individuals with metabolic syndrome and diabetes mellitus (Parhofer & Laufs, 2019). There is robust evidence linking elevated triglyceride levels to increased health risks (Laufs et al., 2020). Notably, research has shown that yogic practices can significantly influence triglyceride metabolism, improving lipid profiles (Shrirang & Surinder, 2015). This highlights the potential of yoga as an intervention for managing triglyceride levels and associated health risks.

High-density lipoprotein (HDL) is integral to human lipid metabolism, with roles extending beyond cholesterol transport (Bailey & Mohiuddin, 2022). Often termed "good cholesterol," HDL plays a crucial role in maintaining cardiovascular and overall health (Chiesa & Charakida, 2019). Its main function is to transfer excess cholesterol from tissues to the liver for processing and elimination (Zhou et al., 2015). This process is vital for preventing cholesterol build-up in arterial walls, and reducing the risk of atherosclerosis and associated cardiovascular conditions (Kosmas et al., 2018).

Low-density lipoprotein (LDL) is the main carrier of serum cholesterol, essential for cellular processes and metabolism, yet it also poses health risks (Liu et al., 2021; Borén et al., 2020; Venugopal et al., 2023). LDL transports approximately 67% of serum cholesterol to essential tissues, such as the adrenal glands and gonads (Venugopal et al., 2023). Epidemiological studies have consistently identified elevated LDL cholesterol levels as a key metabolic risk factor for atherosclerotic cardiovascular disease (ASCVD) (Virani et al., 2023).

Very-low-density lipoproteins (VLDL) are key lipid transporters, synthesized by the liver, that facilitate the delivery of cholesterol and triglycerides to various tissues and organs (Huang & Lee, 2022; Lee et al., 2022). Upon secretion, VLDL interacts with lipoprotein lipase (LPL) on capillary endothelium to release triglycerides for storage or utilization in adipose and muscle tissues (Lee et al., 2022). The metabolism and assembly of VLDL are influenced by factors like insulin resistance and nutrient excess, with VLDL particle size and concentration serving as important markers for metabolic health and diabetes risk (Phillips & Perry, 2015). In addition to lipid transport, VLDL also plays a key role in nitric oxide signaling, which is important for the relaxation of vascular smooth muscle and the regulation of blood pressure (Magnifico et al., 2017), and stimulates aldosterone synthesis in the adrenal glands (Tsai et al., 2017). Thus, VLDL contributes not only to lipid metabolism but also to blood pressure regulation.

The cholesterol-to-high-density lipoprotein (HDL) ratio is considered a key indicator of cardiovascular risk, as it reflects the balance between atherogenic and protective lipoproteins (Millán et al., 2009). An elevated cholesterol/HDL ratio is strongly associated with an increased risk of atherosclerosis, myocardial infarction, and other cardiovascular complications (Millán et al., 2009; Calling et al., 2019; Lemieux et al., 2001), whereas a lower ratio signifies improved lipid metabolism and a reduced likelihood of adverse cardiovascular events (Millán et al., 2009). Given its predictive value, the cholesterol/HDL ratio is widely utilized in clinical and epidemiological settings to assess cardiovascular risk and guide therapeutic interventions (Yu et al., 2018).

Dyslipidemia, characterized by abnormalities in lipid metabolism, is a well-established risk factor for cardiovascular diseases (CVDs) and metabolic disorders (Abera et al., 2024). TG/HDL ratio has gained prominence as a reliable indicator of cardiometabolic risk (Murguía-Romero, et al., 2013), insulin resistance (Chauhan et al., 2021), and atherogenic dyslipidemia (Hermans et al., 2012). A higher TG/HDL ratio has been associated with an increased likelihood of endothelial dysfunction, arterial stiffness, and the progression of atherosclerosis, making it a crucial parameter in cardiovascular risk assessment (Kosmas et al., 2023; Li et al., 2024). Therefore, strategies aimed at optimizing this ratio are of significant clinical interest.

Cardiovascular diseases (CVDs) remain a leading cause of morbidity and mortality worldwide (Vaduganathan et al., 2022), with dyslipidemia being a significant risk factor (Ghodeshwar et al., 2023). Among lipid profile parameters, the low-density lipoprotein (LDL) to high-density lipoprotein (HDL) ratio is a key marker of cardiovascular health (Tamada et al., 2010). A higher LDL/HDL ratio is strongly associated with an increased risk of atherosclerosis and other cardiovascular complications (Sun et al., 2022a), whereas a lower ratio reflects better lipid metabolism and a reduced risk of CVDs (Millán et al., 2009). Monitoring and managing this ratio through lifestyle modifications and appropriate interventions play a crucial role in cardiovascular disease prevention (Ghodeshwar et al., 2023).

Dyslipidaemia plays a crucial role in the progression of atherosclerosis and other cardiovascular complications (Abera et al., 2024). Traditional lipid markers such as low-density lipoprotein cholesterol (LDL-C) have long been used to assess cardiovascular risk (Virani et al., 2023), however, emerging evidence suggests that the non-HDL/HDL ratio serves as a more comprehensive indicator of atherogenic risk (Packard & Saito, 2004). This ratio accounts for a wider range of atherogenic lipoproteins, including very low-density lipoproteins (VLDL) and intermediate-density lipoproteins (IDL), making it a superior predictor of cardiovascular risk compared to LDL-C alone (Virani, 2011). An elevated non-HDL/HDL ratio reflects an imbalance between atherogenic and protective lipoproteins, increasing the likelihood of arterial plaque formation and subsequent cardiovascular events (Millán et al., 2009; Reddy et al., 2024). Given the growing burden of CVDs, there is a critical need for effective and sustainable lifestyle interventions to regulate lipid

metabolism and reduce the non-HDL/HDL ratio, thereby mitigating the overall cardiovascular risk.

The increasing prevalence of lifestyle-related disorders among college students poses a significant public health concern (Yadav et al., 2024). Sedentary behavior, poor diet, academic stress, and irregular physical activity contribute to adverse changes in lipid profiles (Park et al., 2020) and physical fitness (Fadillah et al., 2021), increasing the risk of cardiovascular and metabolic diseases (Verdú et al., 2021). Non-pharmacological interventions like yogic practices offer a cost-effective solution to address these issues.

Yogic practices, including asanas, pranayama, and relaxation, have been shown to improve lipid metabolism and cardiovascular health by lowering total cholesterol (Ghazvineh et al., 2022), triglycerides (Shrirang & Surinder, 2015), low-density lipoprotein (Kumar et al., 2018; Shahnam et al., 2010), and very-low-density lipoprotein (VLDL) while enhancing high-density lipoprotein (Pandian et al., 2021). These modifications contribute to an improved cholesterol/HDL ratio, triglyceride/HDL ratio, LDL/HDL ratio, and non-HDL/HDL ratio, thereby mitigating cardiovascular risk.

Despite these benefits, limited research explores yogic practices on lipid profiles among college students. This study aims to address this gap by evaluating yogic practice's impact on lipid levels. Findings may support integrating yogic practices into college health programs as a sustainable strategy for improving overall well-being.

Materials and Methods

Study Design

The present investigation employed an experimental design utilizing a two-group pre-test–post-test framework to evaluate the effects of a twelve-week yogic intervention on selected serum lipid parameters. Approval for the study was obtained from the Department of Physical Education and Sports Sciences, University of Delhi, following clearance by the Departmental Research Committee and the Board of Research Studies. Before enrolment, students were provided with an oral explanation of the study objectives, and those who voluntarily agreed to participate signed a written informed consent form. The participants were then randomly assigned to one of two groups: the experimental group, which underwent yogic practices, and the control group, which did not receive any intervention. Group allocation was carried out by an independent researcher who was not involved in the assessment procedures.

Participants

The study was conducted at Shyampahari Government Primary Teacher Training Institute, Birbhum, West Bengal, India, and included male college students aged 17 to 22 years. Decimal age was calculated based on the date of birth as documented in the original birth certificates presented by the participants at the time of evaluation (Chakraborty & Singh, 2024). Twenty-four students with normal vision were randomly assigned to either the experimental group or the control group, with twelve students in each group. Table 1 shows the baseline characteristics between the groups, with Levene's test and independent t-test p-values indicating variance homogeneity and baseline differences.

Sample Size

An a priori power analysis was conducted using G*Power software (version 3.1.9.7; University of Kiel, Germany) to determine the minimum required sample size for the study. The analysis was based on an expected large effect size (Cohen's d = 0.80), a significance level of $\alpha = 0.05$, and a desired statistical power of 0.95, in accordance with the guidelines outlined by Kang (2021). The results indicated that a minimum of 23 participants would be required to achieve adequate statistical power. To accommodate potential attrition, 35 participants were initially recruited. Following exclusions and dropouts, a total of 24 participants completed the study protocol and were included in the final analysis. Participants were randomly allocated to either the experimental or control group using an equal allocation ratio (1:1) (Rahaman & Pramanik, 2025).

Table 1. Participant demographics and baseline characteristics

Variables	Experimental Group		Control Group		Levene's test for equality of variances Sig.	t-test for equality of means Sig. (2-tailed)
	Mean	SD	Mean	SD		
Age (years)	19.92	.90	20.42	1.17	.134	.252
Waist-Hip Ratio	.85	.13	.86	.07	.305	.941
Pulse Rate (beats/min)	74.33	3.77	75.50	3.75	.694	.456
Respiratory Rate (breath/min)	23.67	4.33	25.16	3.83	.937	.379
Systolic Blood Pressure (mmHg)	124.08	4.27	123.75	4.35	.969	.852
Diastolic Blood Pressure (mmHg)	82.00	2.49	80.08	3.15	.314	.112
Positive Breath Holding Capacity (breath/min)	68.50	27.23	50.25	24.26	.456	.097
Negative Breath Holding Capacity (breath/min)	24.41	6.97	25.75	10.24	.283	.713

Randomisation

Randomisation was carried out using Random Allocation Software (version 1.0.0; M. Saghaei, MD, Department of Anesthesia, Isfahan University of Medical Sciences, Isfahan, Iran). A total of 24 eligible participants were assigned to the experimental group (n = 12) or the control group (n = 12) based on a computer-generated random sequence. Allocation concealment was ensured through the implementation of sequentially numbered, opaque, sealed envelopes (SNOSE) to minimise selection bias.

Blinding/Masking

Due to the inherent characteristics of the yogic intervention, participant blinding was not feasible. However, to maintain methodological rigor and reduce potential bias, a single-blind design was adopted. The principal investigator remained blinded to group assignments throughout the study. An independent researcher, who was not involved in the randomisation process or data analysis, administered the intervention and conducted all outcome assessments (Govindasamy et al., 2024).

Study Organization

This study employed an experimental research design with a two-group pre-test and post-test methodology to evaluate the effects of a twelve-week yogic intervention. The primary objective was to determine whether the intervention elicited significant enhancements in selected biochemical parameters. Participants were selected using probability sampling techniques from the student population.

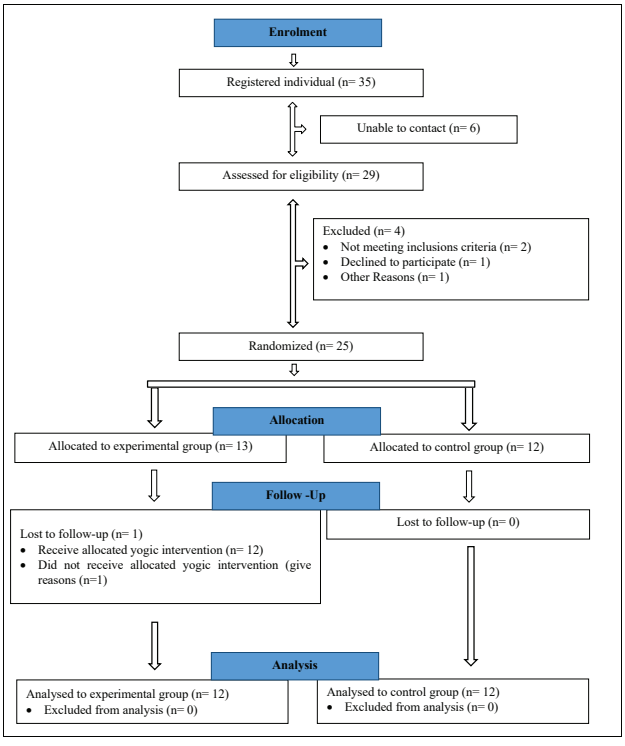

Fig. 1. Participations selection consort flow chart (Rahaman & Pramanik, 2025)

Experimental Protocol

The experimental group participated in a structured yogic practices intervention comprising Suryanamaskar, selected asanas, pranayama techniques, and relaxation practices. These sessions were systematically conducted under the direct supervision of the investigator. The program was conducted six days a week for twelve weeks, with each session lasting sixty minutes, held from 8:00 to 9:00 AM, Monday to Saturday, at the Shyampahari Government Primary Teacher Training Institute ground in Birbhum, West Bengal, India. Conversely, the control group continued with their usual daily routines without any additional interventions. To assess the effects of the intervention, comprehensive evaluations were conducted for all participants both at baseline and upon completion of the twelve-week program. An overview of the intervention protocol is presented in Figure 2.

Weeks	Surya Namaskar (Dynamic Warm-up)	Asanas Practiced (In Sequential Order)	Asana Parameters (Holding Time × Repetitions × Rest)	Total Asana Duration	Pranayama (Anulom Vilom and Bhastrika)				Relaxation (Integrative Recovery)
1–3	1 Round (5 min)	Ardha-Halasana, Sarvangasana, Matsyasana, Halasana, Chakrasana, Naukasana, Bhujangasana, Shalabhasana, Naukasana, Dhanurasana, Ardha Matsyendrasana, Paschimottanasana, Vajrasana, Yogamudra, Ushtrasana, Padmasana, Utkatasana, Trikonasana, Vrikshasana, Tadasana, Shavasana	15 sec × 2 × 5 sec (60 sec rest between sets)	30 (min)	Breathing Ratio (1:1)			Cycle × Repetition × Rest between Repetitions	Shavasana (5 min)
					I		E	2×2×60 Sec	
					5 (Sec)		5 (Sec)		
4–6	2 Rounds (5 min)	Same as above	20 sec × 2 × 5 sec (50 sec rest between sets)	30 (min)	Breathing Ratio (1:1:1)			Cycle × Repetition × Rest between Repetitions	Shavasana (5 min)
					I	H	E	2×2×50 Sec	
					5 (Sec)	5 (Sec)	5 (Sec)		
7–9	3 Rounds (5 min)	Same as above	25 sec × 2 × 3 sec (40 sec rest between sets)	30 (min)	Breathing Ratio (1:2:2)			Cycle × Repetition × Rest between Repetitions	Shavasana (5 min)
					I	H	E	2×2×40 Sec	
					5 (Sec)	10 (Sec)	10 (Sec)		
10–12	4 Rounds (5 min)	Same as above	30 sec × 2 × 3 sec (30 sec rest between sets)	30 (min)	Breathing Ratio (1:4:2)			Cycle × Repetition × Rest between Repetitions	Shavasana (5 min)
					I	H	E	2×2×30 Sec	
					5 (Sec)	20 (Sec)	10 (Sec)		

Fig. 2. Yogic intervention module Note: Inhale (I), Hold (H), and Exhale (E) (Rahaman et al., 2025; Rahaman & Pramanik, 2025)

Outcome Measures

The current study evaluated various biochemical and bio-motor variables to assess the effects of a 12-week yogic intervention. These variables included cholesterol levels, triglycerides, HDL, LDL, and VLDL, cholesterol/HDL ratio, triglyceride/HDL ratio, LDL/HDL ratio, and non-HDL/HDL ratio. Both pre-test (baseline) and post-test (following the intervention) measurements were collected to provide comparative data. Throughout the assessment process, participant safety remained a priority, and constant supervision was provided to ensure adherence to the established protocols.

Blood samples were drawn for lipid profile analysis, including total cholesterol, LDL, HDL, triglycerides, VLDL, cholesterol/HDL ratio, LDL/HDL ratio, triglyceride/HDL ratio, LDL/HDL ratio, and non-HDL/HDL ratio. The venous blood was extracted from the antecubital vein using

a sterile syringe, ensuring aseptic conditions throughout the procedure. These samples were then transported to a certified pathology laboratory for analysis. Lipid profile testing was performed using the TULIP CORALYZER SMART 200, a fully automated system that ensured the precision and reliability of the lipid measurements. To guarantee the accuracy and reproducibility of results, all analyses followed rigorous laboratory protocols and quality control standards. All assessments were conducted with adherence to standard protocols, ensuring reliable, valid, and reproducible results. These measures helped minimize errors and enhance consistency across participants.

Statistical Analysis

Data normality was assessed with the Shapiro-Wilk test (Shapiro & Wilk, 1965), and Levene's test was used to check variance equality. Descriptive statistics were computed, and paired t-tests and independent samples t-tests were applied for within-group and between-group comparisons, respectively. All analyses were performed using IBM SPSS software (Version 25), with a significance level of 0.05.

Results

Table 3 provides the descriptive statistics for both the experimental (EG) and control (CG) groups, showing the changes in cholesterol, triglyceride, HDL, LDL, VLDL, cholesterol/HDL ratio, triglyceride/HDL ratio, LDL/HDL ratio, and non-HDL/HDL ratio, from pre-test to post-test. These results highlight the effectiveness in enhancing cardiovascular functions.

Table 4 presents the paired t-test results, showing significant changes in various physiological parameters among participants in the experimental group (EG) following the intervention. The EG exhibited statistically significant improvements in total cholesterol $t_{(11)} = 2.32$, $p = .041$; triglycerides $t_{(11)} = 2.86$, $p = .015$; HDL (high-density lipoprotein) $t_{(11)} = 2.26$, $p = .045$; VLDL (very low-density lipoprotein) $t_{(11)} = 2.70$, $p = .021$; triglyceride/HDL ratio $t_{(11)} = 3.70$, $p = .003$; and non-HDL/HDL Ratio $t_{(11)} = 3.82$, $p = .003$. These changes suggest that the intervention positively influenced lipid metabolism, which may contribute to improved cardiovascular health. However, LDL (low-density lipoprotein) did not show a significant change in the EG $t_{(11)} = .66$, $p = .524$, indicating that the intervention did not significantly affect LDL levels. The LDL/HDL ratio in the experimental group (EG) did not show a statistically significant change from pre-test to post-test, $t_{(11)} = 1.55$, $p = .149$, but improved compared to baseline values. Similarly, the total cholesterol/HDL ratio in the EG remained statistically unchanged, $t_{(11)} = .75$, $p = .469$, but showed improvement following the intervention. These findings suggest that while the intervention did not produce statistically significant changes, there was a positive trend in lipid profile improvement. In contrast, the control group (CG) did not show significant changes in any of the physiological variables. Specifically, total cholesterol $t_{(11)} = 2.13$, $p = .057$; triglycerides $t_{(11)} = 1.12$, $p = .287$; HDL $t_{(11)} = 1.91$, $p = .082$; LDL $t_{(11)} = 1.42$, $p = .184$; and VLDL $t_{(11)} = 1.30$, $p = .219$; total cholesterol/HDL ratio $t_{(11)} = 1.37$, $p = .198$; triglyceride/HDL Ratio $t_{(11)} = .54$, $p = .603$; LDL/HDL ratio $t_{(11)} = .88$, $p = .397$; and non-HDL/HDL Ratio $t_{(11)} = 1.06$, $p = .311$ did not exhibit significant changes.

Table 3. Descriptive statistics

Variables	Group	Test	N	Mean	SD	% Change
Total Cholesterol (mg/dl)	EG	Pre-test	12	162.50	31.47	-10.87
		Post-test	12	144.83	14.92	
	CG	Pre-test	12	167.33	43.79	11.50
		Post-test	12	186.58	32.55	
Triglyceride (mg/dl)	EG	Pre-test	12	154.08	85.25	-30.83
		Post-test	12	106.58	49.88	
	CG	Pre-test	12	136.42	41.23	11.60
		Post-test	12	152.25	69.59	
HDL (mg/dl)	EG	Pre-test	12	40.92	2.64	6.01
		Post-test	12	43.38	2.92	
	CG	Pre-test	12	40.17	2.62	6.62
		Post-test	12	42.83	5.16	
LDL (mg/dl)	EG	Pre-test	12	90.77	29.37	-3.64
		Post-test	12	87.47	17.56	
	CG	Pre-test	12	99.88	39.96	12.61
		Post-test	12	112.47	31.40	
VLDL(mg/dl)	EG	Pre-test	12	30.82	17.05	-29.36
		Post-test	12	21.77	9.78	
	CG	Pre-test	12	27.28	8.25	13.16
		Post-test	12	30.87	13.51	
Total Cholesterol /HDL Ratio	EG	Pre-test	12	3.63	1.31	-7.71
		Post-test	12	3.35	.38	
	CG	Pre-test	12	3.81	1.54	16.01
		Post-test	12	4.42	1.01	
Triglyceride/ HDL Ratio	EG	Pre-test	12	3.68	1.77	-33.15
		Post-test	12	2.46	1.12	
	CG	Pre-test	12	3.38	.98	5.03
		Post-test	12	3.55	1.54	
LDL/HDL Ratio	EG	Pre-test	12	2.22	.72	-9.01
		Post-test	12	2.02	.39	
	CG	Pre-test	12	2.47	.94	8.50
		Post-test	12	2.68	.95	
Non-HDL/HDL Ratio	EG	Pre-test	12	2.96	.65	-20.61
		Post-test	12	2.35	.38	
	CG	Pre-test	12	3.14	.97	8.92
		Post-test	12	3.42	1.01	

These findings indicate that the intervention had a significant impact on various health markers in the EG, particularly improving lipid profiles (except for LDL). The lack of significant changes in the CG further supports the effectiveness of the intervention. Overall, these results suggest that the intervention played a key role in enhancing important physiological markers, with potential benefits for cardiovascular health.

Table 5 presents independent t-test results comparing pre-and post-test scores between the experimental and control groups for various biochemical variables. In the pre-test, there were no significant differences between the EG and CG for any of the variables. Specifically, total cholesterol $t_{(22)} = .31$, $p = .759$; triglycerides $t_{(22)} = .65$, $p = .525$; HDL $t_{(22)} = .70$, $p = .493$; LDL $t_{(22)} = .64$, $p = .531$; VLDL $t_{(22)} = .65$,

Table 4. A paired t-test compared the pre-test and post-test within the experimental and control groups

Variables	Group	Test	Mean Difference	SD	Std. Error Mean	t	df	Sig. (2-tailed)
Total Cholesterol	EG	Pre-test Post-test	17.67	26.41	7.62	2.32	11	.041*
	CG	Pre-test Post-test	19.25	31.31	9.04	2.13	11	.057
Triglyceride	EG	Pre-test Post-test	47.50	57.49	16.60	2.86	11	.015*
	CG	Pre-test Post-test	15.83	49.05	14.16	1.12	11	.287
HDL	EG	Pre-test Post-test	2.47	3.78	1.09	2.26	11	.045*
	CG	Pre-test Post-test	2.67	4.83	1.39	1.91	11	.082
LDL	EG	Pre-test Post-test	3.30	17.37	5.01	.66	11	.524
	CG	Pre-test Post-test	12.58	30.74	8.88	1.42	11	.184
VLDL	EG	Pre-test Post-test	9.05	11.63	3.36	2.70	11	.021*
	CG	Pre-test Post-test	3.58	9.53	2.75	1.30	11	.219
Total Cholesterol /HDL Ratio	EG	Pre-test Post-test	.28	1.27	.37	.75	11	.469
	CG	Pre-test Post-test	.61	1.53	.44	1.37	11	.198
Triglyceride/HDL Ratio	EG	Pre-test Post-test	1.22	1.14	.33	3.70	11	.003*
	CG	Pre-test Post-test	.17	1.10	.32	.54	11	.603
LDL/HDL Ratio	EG	Pre-test Post-test	.21	.46	.13	1.55	11	.149
	CG	Pre-test Post-test	.22	.86	.25	.88	11	.397
Non-HDL/HDL Ratio	EG	Pre-test Post-test	.60	.55	.16	3.82	11	.003*
	CG	Pre-test Post-test	.28	.90	.26	1.06	11	.311

*Significant at 0.05 level

p = .524; total cholesterol/HDL ratio $t_{(22)}$ = .31, p = .757; triglyceride/HDL ratio $t_{(22)}$ = .51, p = .616; LDL/HDL ratio $t_{(22)}$ = .71, p = .487; and non-HDL/HDL ratio $t_{(22)}$ = .54, p = .594, all showed no statistically significant differences between the groups. However, in the post-test, several significant differences were observed in favor of the EG. Total cholesterol $t_{(22)}$ = 4.04, p = .001; LDL levels $t_{(22)}$ = 2.41, p = .025; total cholesterol/HDL ratio $t_{(22)}$ = 3.43, p = .002; LDL/HDL ratio $t_{(22)}$ = 2.25, p = .035; non-HDL/HDL ratio $t_{(22)}$ = 3.43, p = .002; and showed significant improvements in the EG compared to the CG. Although there were improvements in triglycerides $t_{(22)}$ = 1.85, p = .078; VLDL $t_{(22)}$ = 1.89, p = .072; triglyceride/HDL ratio $t_{(22)}$ = 1.98, p = .060; these changes did not reach statistical significance. Furthermore, no significant differences were found in HDL $t_{(22)}$ = .32, p = .751. These findings suggest that the experimental intervention

Table 5. An independent t-test compared pre-test and post-test scores between the experimental and control groups

Variables	Tests	Experimental		Control		t	P-value
		Mean	SD	Mean	SD		
Total Cholesterol	Pre-test	162.50	31.47	167.33	43.79	.31	.759
	Post-test	144.83	14.92	186.58	32.55	4.04	.001*
Triglyceride	Pre-test	154.08	85.25	136.42	41.23	.65	.525
	Post-test	106.58	49.88	152.25	69.59	1.85	.078
HDL	Pre-test	40.92	2.64	40.17	2.62	.70	.493
	Post-test	43.38	2.92	42.83	5.16	.32	.751
LDL	Pre-test	90.77	29.37	99.88	39.96	.64	.531
	Post-test	87.47	17.56	112.47	31.40	2.41	.025*
VLDL	Pre-test	30.82	17.05	27.28	8.25	.65	.524
	Post-test	21.77	9.78	30.87	13.51	1.89	.072
Total Cholesterol /HDL Ratio	Pre-test	3.63	1.31	3.81	1.54	.31	.757
	Post-test	3.35	.38	4.42	1.01	3.43	.002*
Triglyceride/HDL Ratio	Pre-test	3.68	1.77	3.38	.98	.51	.616
	Post-test	2.46	1.12	3.55	1.54	1.98	.060
LDL/HDL Ratio	Pre-test	2.22	.72	2.47	.94	.71	.487
	Post-test	2.02	.39	2.68	.95	2.25	.035*
Non-HDL/HDL Ratio	Pre-test	2.96	.65	3.14	.97	.54	.594
	Post-test	2.35	.38	3.42	1.01	3.43	.002*

*Significant at 0.05 level

contributed to significant improvements in biochemical parameters such as total cholesterol, LDL levels, total cholesterol/HDL ratio, LDL/HDL ratio, and non-HDL/HDL ratio. However, no significant changes were observed in other variables, such as triglycerides, VLDL, HDL, and triglyceride/HDL ratio.

Discussions

The data in Table 4 indicate a significant reduction in total cholesterol following a yogic intervention, particularly in the experimental group, observed at both pre-test and post-test stages. This aligns with previous studies highlighting yogic practices role in managing cholesterol levels. For example, a 12-week yogic practices intervention reduced total cholesterol from 244.86 mg/dL to 219.54 mg/dL (Shantakumari et al., 2013), and another study reported a reduction from 213.1 mg/dL to 193.4 mg/dL (Malarvizhi & Elangovan, 2015). A systematic review of 53 studies involving over 13,000 participants revealed a significant reduction of approximately 10.31 mg/dL in total cholesterol (Ghazvineh et al., 2022). These findings suggest that yogic practices may positively impact cholesterol levels through mechanisms like improved liver function, enhanced hepatic lipase activity (Shantakumari et al., 2013; Shradha & Sisodia, 2010), better insulin sensitivity (Sahay, 2007; Dewangani et al., 2020), stress reduction via lower cortisol levels (Bijlani et al., 2005), and weight management (Cramer et al., 2016; Sun et al., 2022).

Several studies further support the notion that regular yogic practices can effectively reduce triglyceride levels in diverse populations, including college students. A study involving urban boys showed significant improvements in triglyceride levels among those who practiced yogic practices compared to a control group (Vidhya & Rani, 2021). Another study with 50 participants revealed that yogic practices for three months lowered triglyceride levels from an average of 151.88 mg/dL to 130.11 mg/dL (Shantakumari et al., 2013). A systematic review and meta-analysis of 53 studies involving 13,191 participants confirmed that yogic practice interventions significantly reduced triglycerides by an average of 13.50 mg/dL (Ghazvineh et al., 2022). These reductions in triglycerides may be attributed to various physiological benefits of yogic practices, such as enhanced lipoprotein lipase activity, improved liver function, and better insulin sensitivity (Shantakumari et al., 2013; Sahay, 2007; Dewangani et al., 2020). Moreover, yogic practice's stress-reducing properties through decreased cortisol levels also play a role in reducing central obesity and insulin resistance, which further contribute to improved lipid profiles (Bijlani et al., 2005; Shantakumari et al., 2013).

In addition to lowering total cholesterol and triglycerides, the study observed a significant increase in high-density lipoprotein (HDL) levels after 12 weeks of yogic practice interventions. This finding is consistent with previous studies demonstrating the positive impact of yogic practices on lipid profiles. For example, a brief yogic practices intervention has been shown to elevate HDL levels from 42.93 mg/dL to 43.52 mg/dL ($P = 0.043$), particularly in individuals with lower baseline HDL (Yadav et al., 2014). A 12-week study also found that regular yogic practices practice significantly improved HDL levels, further

supporting yogic practices' benefits for lipid metabolism (Pandian et al., 2021). Additionally, yogic practices have been linked to improved HDL levels, contributing to better weight management and cardiovascular health (Oza et al., 2019). Yogic practice's impact on HDL levels may be linked to stress reduction through decreased cortisol levels, as well as stimulation of the endocrine system, which regulates cholesterol metabolism and HDL production (The Indian Express, 2023). Additionally, yogic practice's ability to enhance hepatic and lipoprotein lipase activity helps promote triglyceride uptake by adipose tissue and improve lipoprotein metabolism (Shantakumari et al., 2013; Shradha & Sisodia, 2010), which may also support the reverse cholesterol transport mechanism mediated by HDL, helping remove excess cholesterol from peripheral tissues to the liver (Benisek, 2023).

The reduction in LDL cholesterol levels observed in the current study, from a pre-test mean of 90.77 mg/dL to a post-test mean of 87.47 mg/dL, aligns with previous research indicating that yogic practices can positively influence lipid profiles. Although the reduction was modest and not statistically significant at the 0.05 significance level, it is consistent with other studies. For example, Chowdhury (2018) reported a slight decrease in LDL from 126.46 mg/dL to 124.02 mg/dL, and Babu (2018) found a reduction from 165.33 mg/dL to 159.06 mg/dL in college men. Similarly, Chandrashekhar (2012) observed a decrease from 108.9 mg/dL to 104.1 mg/dL, and Dubey et al. (2014) noted a reduction from 118.9 mg/dL to 115.62 mg/dL. The current study's modest reduction in LDL levels may be attributed to factors such as yogic practices' ability to reduce stress and lower cortisol levels, which are linked to elevated LDL (Kumar et al., 2018; Shahnam et al., 2010). Additionally, yogic practices promote weight loss and fat reduction, which can improve cholesterol balance (Oda, 2018; Upadhyah et al., 2019). Enhanced insulin sensitivity from yogic practices also contributes to improved lipid metabolism and better regulation of LDL cholesterol (Alidu et al., 2023; Gowri et al., 2022).

The present study also found a significant reduction in VLDL levels in the experimental group following yogic practices intervention, while no significant change was observed in the control group. This aligns with existing literature suggesting that yogic practices-based interventions can positively influence VLDL levels (Prasad et al., 2006). The decline in VLDL may be attributed to yogic practices's physiological benefits, including improved metabolic function (Doddoli et al., 2017), enhanced lipid oxidation (Promsrisuk et al., 2023), and better insulin sensitivity (Gowri et al., 2022). Furthermore, yogic practices such as asanas, pranayama, and relaxation techniques have been shown to modulate lipid profiles by reducing stress, enhancing cardiac autonomic function (Cramer et al., 2014), and improving circulation (Pal et al., 2011), all of which contribute to better lipid metabolism and reduced cardiovascular risk factors.

The present study demonstrates significant improvements in lipid profile ratios in the experimental group (EG) following yogic practices, while the control group (CG) exhibited minimal or adverse changes. These findings align with previous studies indicating that yogic practice enhances lipid metabolism and cardiovascular health. Research has shown that regular yogic practice reduces total cholesterol (Shantakumari et al., 2013), triglycerides (Vidhya & Rani, 2021), LDL (Chandrashekhar, 2012), and VLDL (Prasad et al., 2006), while increasing HDL (Yadav et al., 2014), leading to favorable changes in lipid ratios such as Cholesterol/HDL, Triglyceride/HDL, LDL/HDL, and Non-HDL/HDL. These results support the role of yogic practice as a non-invasive intervention for optimizing lipid profiles and reducing cardiovascular risk.

Limitations and future of the study

Despite the promising findings, this study has several limitations that warrant consideration. The relatively small sample size (n = 24) may constrain the statistical power and limit the generalizability of the results. The study population was restricted to male college students from a single institution, which may reduce the applicability of the findings to broader populations, including females and individuals of different age groups, socioeconomic statuses, and educational backgrounds. Additionally, key lifestyle variables such as dietary intake, sleep patterns, and psychological stress—which are known to influence lipid profiles—were not controlled or monitored. The absence of follow-up assessments also precludes conclusions about the long-term sustainability of the observed effects. Future research incorporating larger and more diverse cohorts, with comprehensive control of confounding variables and extended follow-up periods, is recommended to validate and extend these findings.

Strength and Implications

The principal strength of this study lies in the methodological rigor with which the intervention was designed and implemented. The use of a randomized controlled design enhanced internal validity, while the clearly defined 12-week yogic protocol—administered consistently in terms of duration, frequency, and content—ensured the systematic delivery of the intervention. The integration of both biochemical assessments, via automated analyzers, enabled a comprehensive assessment of both physiological and functional outcomes. Furthermore, the application of appropriate statistical procedures, including tests for normality and homogeneity of variance, along with paired and independent samples t-tests, strengthened the reliability and interpretability of the findings.

From a practical standpoint, the study offers valuable implications for health promotion among young adult populations. The significant improvements observed in lipid parameters such as HDL, non-HDL/HDL ratio, and triglyceride indices suggest that yogic practices may serve as an effective, non-pharmacological strategy for improving cardiovascular health. Given the accessibility, cost-effectiveness, and cultural relevance of yogic interventions, the findings support their inclusion in health and wellness initiatives within academic institutions. Moreover, the study contributes to the growing body of evidence advocating for holistic, lifestyle-based approaches to disease prevention and health optimization in emerging adults.

Conclusions

This study found that a twelve-week yogic practice significantly improved several biochemical parameters in the

experimental group, with no changes observed in the control group. Notable reductions in total cholesterol, triglycerides, VLDL levels, triglyceride/HDL ratio, and non-HDL/HDL ratio were observed, along with a significant increase in HDL levels. The reductions in low-density lipoprotein (LDL), total cholesterol/HDL ratio, and LDL/HDL ratio did not reach statistical significance; however, they demonstrated an improvement from baseline values. The results suggest that yogic practices are an effective non-pharmacological approach for improving lipid. These practices could be beneficial for managing dyslipidemia, and supporting rehabilitation and fitness programs. Future research should explore long-term effects and optimal intervention duration.

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Author Contributions

AR contributed to the conception, design, data collection, and data analysis. He also prepared the tables and figures, drafted the manuscript, and revised and finalized it for publication. TNP contributed to the conception, design, planning, and supervision of the research. He set the goals, provided substantive supervision, and finalized the manuscript for publication.

Approval and Consent to Participate

This study was approved by the Department of Physical Education and Sports Sciences, University of Delhi, following clearance from the Department Research Committee and the Board of Research Studies (Ref. no. SF-1/Ph. D/2023/1481) Informed consent was obtained from all participants after a detailed briefing on the study's objectives, procedures, and their rights, including voluntary participation and the option to withdraw at any stage.

Data Availability Statement

The authors can provide data upon reasonable request.

Conflicts of Interest

The authors state that there is no potential conflict of interests.

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Використання йогічної інтервенції знижує рівень ліпідів у сироватці крові та коефіцієнти атерогенності: Комплексне дослідження

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 5 табл., 2 рис., 87 джерел.

Історія питання. Оптимальна регуляція ліпідів є ключовим визначальним чинником здоров'я серцево-судинної системи. Порушення ліпідного обміну пов'язані з підвищеним ризиком розвитку серцево-судинних захворювань. Йогічні практики демонструють потенціал у модулюванні біохімічних та серцево-судинних параметрів.

Мета дослідження. Метою представленого дослідження було вивчення впливу дванадцятитижневої структуризованої інтервенції з йогічної практики на окремі параметри ліпідного профілю, а саме: загальний холестерин, тригліцериди, ліпопротеїни високої щільності (ЛПВЩ), ліпопротеїни низької щільності (ЛПНЩ), ліпопротеїни дуже низької щільності (ЛПДНЩ), співвідношення холестерин/ЛПВЩ, співвідношення тригліцериди/ЛПВЩ, співвідношення ЛПНЩ/ЛПВЩ та співвідношення не-ЛПВЩ/ЛПВЩ серед студентів чоловічої статі.

Матеріали та методи. Двадцять чотири студенти (віком 17–22 роки) з Державного інституту підготовки вчителів початкової школи в Ш'ямпахарі, Індія, було розподілено за методом рандомізації на експериментальну (n = 12) та контрольну (n = 12) групи. Учасники експериментальної групи практикували йогу протягом 1 години на день, 6 днів на тиждень, впродовж 12 тижнів, тоді як учасники контрольної групи продовжували займатися стандартними видами діяльності. Зразки венозної крові було зібрано на перед- та постінтервенційному етапах дослідження і проаналізовано за допомогою автоматичного біохімічного аналізатора. Внутрішньогрупові відмінності оцінювали із застосуванням t-критеріїв для парних вибірок, а міжгрупові порівняння — за допомогою t-критеріїв для незалежних вибірок. Статистичну значущість встановлено на рівні α = 0.05.

Результати. Експериментальна група показала істотне зниження рівня загального холестерину (p = .041), тригліцеридів (p = .015), ЛПДНЩ (p = .021), співвідношення тригліцеридів/ЛПВЩ (p = .003) та співвідношення не-ЛПВЩ/ЛПВЩ (p = .003), а також підвищення рівня ЛПВЩ (p = .045). Водночас рівень ЛПНЩ (p = .524), співвідношення ЛПНЩ/ЛПВЩ (p = .149) та співвідношення холестерину/ЛПВЩ (p = .469) не зазнали змін. У контрольній групі значних змін не спостерігалося.

Висновки. Результати дослідження свідчать, що структурована програма йоги сприяє покращенню ліпідного обміну і продуктивності серцево-судинної системи, підтверджуючи доцільність застосування йоги як ефективної нефармакологічної інтервенції для молодого дорослого населення.

Ключові слова: йога, ліпіди, серцево-судинні захворювання, холестерин, тригліцериди, ліпопротеїни.

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