

Efficacy of AYUSH Common Yoga protocol along with *Surya Namaskar* on the Dyslipidemia subjects in Haryana

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KEY WORDS

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ABSTRACT

Background: Dyslipidemia might be the cause of many cardiovascular diseases (CVD). Yoga intervention is known to prevent the progression of various lifestyle-based health conditions. Dyslipidemia marks the onset of early CVD, and a Yoga based-intervention at this stage might reverse the progression.

Aim: To analyze the effect of AYUSH Common Yoga Protocol (CYP) and CYP combined with *Surya Namaskar* (CYP-SN) on dyslipidemia subjects in Haryana.

Method: A three-arm randomized controlled trial was carried out in which ninety individuals were allocated into three groups, CYP group, CYP-SN group and control group.

Result: The three-month intervention resulted in elevation of HDL- cholesterol (HDL-C) levels in the group that had undergone CYP protocol, as well as CYP-SN protocol, implying the benefits of *Surya Namaskar* in modifying lipid profile reflecting an improvement in the dyslipidemia.

Conclusion: CYP and CYP-SN Yoga group when practiced regularly for a sustained period can help in reducing co-morbidity and severe CVD in subjects with dyslipidemia. When implemented in dynamic way, CYP-SN has shown to have a greater impact in management of dyslipidemia.

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Introduction

Dyslipidemia is a modifiable risk factor for cardiovascular disease associated mortality and morbidity (1). Patients with cardiovascular disease (CVD) have disturbed level of LDL cholesterol (LDL-C), elevated triglycerides, and reduced HDL cholesterol (HDL-C) levels in the blood. The combination of elevated triglycerides and reduced HDL-C is of paramount importance in detecting the onset of an underlying disorder of glucose homeostasis, insulin resistance (IR), or Diabetes Mellitus (DM2). Numerous studies have shown a relationship between lifestyle-related disorders such as dyslipidemia, diabetes, and hypertension (1–3). Dyslipidemia is related to the increased risk for accumulation of diabetes and hypertension (2,3). Concisely, dyslipidemia, diabetes, hypertension, and obesity contributed to the elevation of CVD (4). This is observed that more than 50% adult population has dyslipidemia across the world (2–4). An epidemiological study in India reported that 25–30% of urban and 15–20% of the rural population

have elevated levels of cholesterol (5). Dyslipidemia is an alteration in the lipoprotein metabolism that encompasses lipoprotein overproduction/deficiency. It is also reported that patients who has background of ischemic stroke, Transient ischemic attack (TIA) and atherosclerosis having LDL-C level of less than 70 mg/dL possess less risk of subsequent stroke and other CVD than those who had LDL cholesterol of 90 mg/dL to 110 mg/dL (6). Recent findings show that pharmacological drugs like Ezetimibe or Proprotein convertase subtilisin–Kexin type 9 inhibitors plus statins can be beneficial in stroke reduction owing to their triglyceride lowering properties (7). Regardless of medications, patients are advised to adopt a healthy lifestyle and regular exercise for CVD risk reduction. After considering comorbidities, statin therapy is recommended for further prevention (6). In India, the estimated economic burden of heart disease on non-medical spending per person amounts to INT\$110.64 (INT-international dollar) annually, hence suggesting dyslipidemia as a factor contributing to the financial burden (8). In addition to this, various

studies have shown the effectiveness of mind-body intervention in reducing triglycerides levels, hence preventing progression of dyslipidemia into advanced CVD (9).

Yoga is an ancient Indian technique that aims to balance mind and body through Yoga postures (*asanas*) and breathing practices (*pranayama*), followed by meditation (*dhyana*). Yoga intervention has been shown to maintain body mass index blood pressure, heart rate, respiratory system while reducing psychological stress and inflammatory conditions (9–11). Yoga has also been proven to significantly reduce the lipid concentrations such as TG, VLDL and LDL levels in CKD patients (12). Moreover, the studies conducted on Indian people with diabetes and pre-diabetes proven that yoga-based lifestyle intervention programs assist in alleviating the comorbidity related with dyslipidemia in both genders and

rural/urban areas (13–14). Therefore, it is a cost-effective and non-pharmacological method to manage blood dyslipidemia and prevent progression as well early development of CVD. In this study, we aimed to test the standardized CYP in one group and CYP-SN in another group, for its health benefits in patients with dyslipidemia condition.

Methods

Study design

The current study was a three-arm randomized controlled trial to analyze the effect of CYP and CYP-SN on dyslipidemia subjects in Haryana, India. The study was started after approval from the Institutional Ethical Committee of Haryana Yog Council.

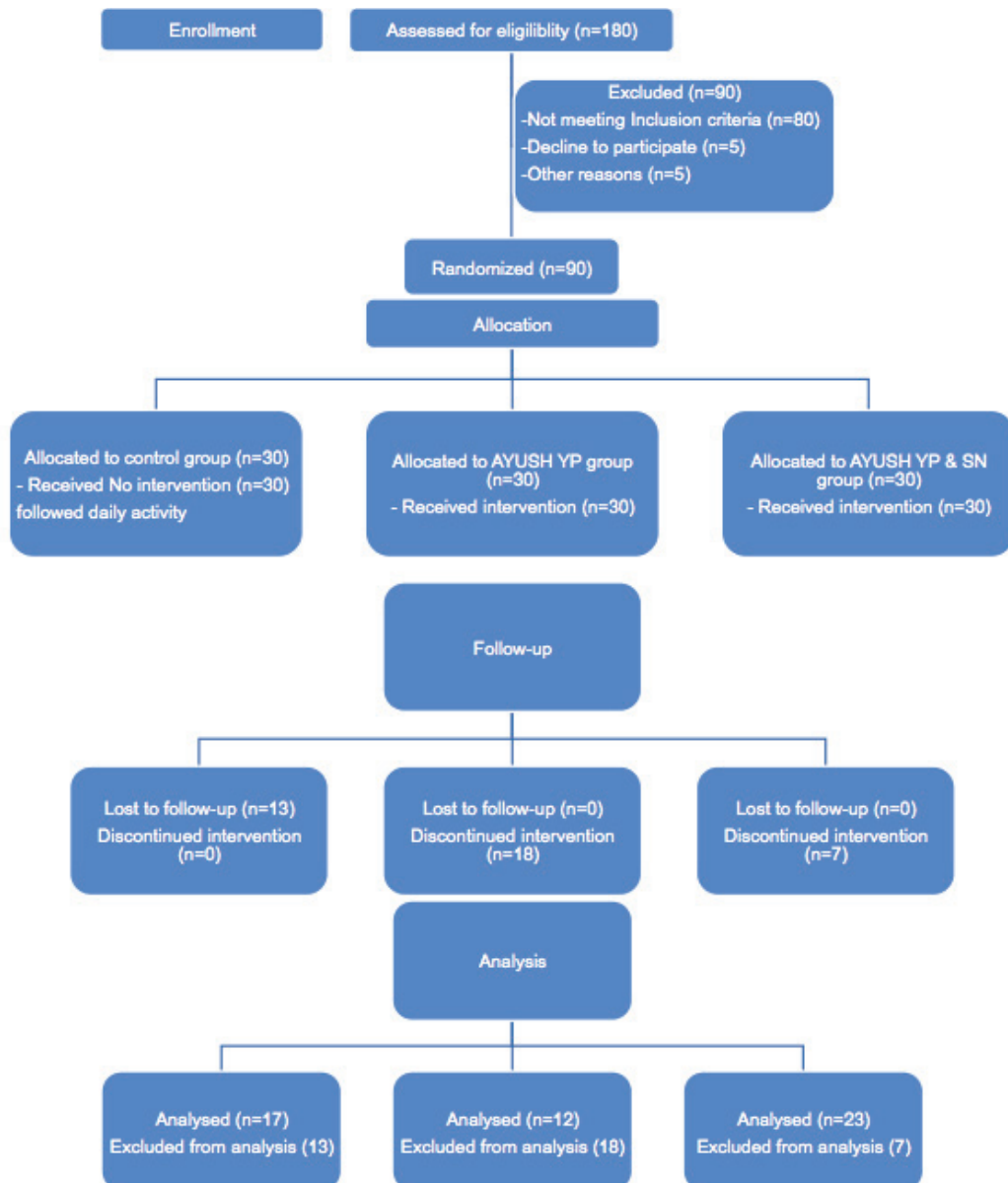


Figure 1: Flow chart of study participants

Participants

The study was conducted from October 2020 to January 2021. The patients were recruited from *Prakratik Chikitsalya*, Bhiwani district, Haryana, India. Based on inclusion and exclusion criteria we have selected the participants for the study. The inclusion criteria were a) Age: 25–55 years, b) B.P: 140/120mmhg or above, c) Both Genders (Male/Female), d) Mild to Moderate patients with Dyslipidemia. The exclusion criteria were a) pregnant women b) people receiving chemotherapy c) patients with severe dyslipidemia d) patients with severe hypertension, heart disease, or any medical condition, e) person who is already a yoga practitioner.

Screening and recruitment

Only those participants who had given written consent were screened through lipid profile tests. Further, A total of 90 participants were screened from 180 screened participants based on deranged lipid profile test scores.

Sample size calculation

The sample size was calculated based on the previous paper on yoga therapy on lipid profile with 80% power and 0.05 relative precision (15). The total calculated sample size was 90 (30 in each group).

Randomization

After recruitment, 90 participants were equally randomized into 3 group's viz. control group (n = 30), CYP (n = 30), CYP-SN group by lottery methods.

Intervention

Among the three groups, 1st group *i.e.* control group followed their daily routine for three months without any intervention. 2nd group *i.e.* CYP practiced common yoga protocol (13) (Table 1), 3rd group *i.e.* practiced CYP-SN (Fast Surya-Namaskar) for three months (Table 2). Both groups (2 and 3) practiced 5 days per week for three months. The duration for the protocol for 2nd group and 3rd group was 45 minutes and 1 hour, respectively.

Table 1: Description of Common Yoga Protocol for AYUSH YP group

Common Yoga Protocol			
SL. No.	Practice		Duration (minutes)
1.	Prayer		2
2.	Loosening Practices	Neck Bending (<i>Grivā Śakti Vikāsaka</i>)	5
		Shoulder's movement	
		Trunk Movement (<i>Kati Śakti Vikāsaka</i>)	
		Knee Movement	
3.	Yogasanas	Standing Postures	
		<i>Tāḍāsana</i>	1
		<i>Ṃṛkāsana</i>	1
		<i>Pāda-Hastāsana</i>	1
		<i>Ardha Cakrāsana</i>	1
<i>Trikoṅāsana</i>	1		

	Sitting Postures	<i>Bhadrāsana</i>	1
		<i>Vajrāsana/Virāsana</i>	1
		<i>Ardha Uṣṭrāsana</i> (for beginners)	1
		<i>Uṣṭrāsana</i>	1
		<i>Śaśankāsana</i>	1
		<i>Uttāna Maṇḍūkāsana</i>	1
	Prone Postures	<i>Marichyāsana/Vakrāsana</i>	1
		<i>Makarāsana</i>	1
		<i>Bhujāṅgāsana</i>	1
	Supine Postures	<i>Śalabhāsana</i>	1
		<i>Setubandhāsana</i>	1
		<i>Uttānapādāsana</i>	1
		<i>Ardhahalāsana</i>	1
		<i>Pavanamuktāsana</i>	1
		<i>Śavāsana</i>	1
4.	<i>Kapālabhāti</i>		2
5.	<i>Prāṇāyāma</i>	<i>Naḍīśodhana/Anuloma Viloma Prāṇāyāma</i>	2
		<i>Śītalī Prāṇāyāma</i>	2
		<i>Bhrāmari Prāṇāyāma</i>	2
6.	<i>Dhyāna</i>		8
7.	<i>Sankalpa</i>		1
8.	<i>Śāntiḥ Pāṭha</i>		1
Total Time			45 minutes

Table 2: Description of CYP-SN Group protocol

Common Yoga Protocol + Surya Namaskara			
SL. No.	Practice		Duration (minutes)
1.	Prayer		2
2.	Loosening Practices	Neck Bending (<i>Grivā Śakti Vikāsaka</i>)	5
		Shoulder's movement	
		Trunk Movement (<i>Kati Śakti Vikāsaka</i>)	
		Knee Movement	
3.	Standing Postures	<i>Tāḍāsana</i>	1
		<i>Ṃṛkāsana</i>	1
		<i>Pāda-Hastāsana</i>	1
		<i>Ardha Cakrāsana</i>	1
		<i>Trikoṅāsana</i>	1
	Sitting Postures	<i>Bhadrāsana</i>	1
		<i>Vajrāsana/Virāsana</i>	1
		<i>Ardha Uṣṭrāsana</i> (for beginners)	1
		<i>Uṣṭrāsana</i>	1
		<i>Śaśankāsana</i>	1
		<i>Uttāna Maṇḍūkāsana</i>	1
	Prone Postures	<i>Marichyāsana/Vakrāsana</i>	1
		<i>Makarāsana</i>	1
		<i>Bhujāṅgāsana</i>	1
		<i>Śalabhāsana</i>	1
Supine Postures	<i>Setubandhāsana</i>	1	
	<i>Uttānapādāsana</i>	1	
	<i>Ardhahalāsana</i>	1	
	<i>Pavanamuktāsana</i>	1	
		<i>Śavāsana</i>	1
4.	<i>Kapālabhāti</i>		2
5.	<i>Prāṇāyāma</i>	<i>Naḍīśodhana/Anuloma Viloma Prāṇāyāma</i>	2
		<i>Śītalī Prāṇāyāma</i>	2
		<i>Bhrāmari Prāṇāyāma</i>	2
6.	<i>Dhyāna</i>		8
7.	<i>Sankalpa</i>		1
8.	<i>Śāntiḥ Pāṭha</i>		1
9.	6 rounds <i>Surya Namaskara</i> (12 steps)		2 min per round (2 × 6 = 12 min) + 3 min relaxation = 15 min
Total Time			60 minutes

Outcome measures

Outcomes Measures included estimation of parameters such as Total Cholesterol, Triglycerides, HDL (High density Lipoprotein), VLDL (Very Low density Lipoprotein), LDL, TC-HDL Ratio, LDL-HDL Ratio at baseline and after three months. The estimation for the lipid parameters was done in the NABL compliant lab.

Statistical analysis

The statistical analysis in the present study was done by using the SPSS 21 software. One-sample Kolmogorov-Smirnov test was done to check the normality of the data. The P-value of the normality test was >0.05 , hence all the data were normally distributed. To compare pre and post data we performed Paired Sample test (Parametric test). To find out the differences between the CYP group, CYP-SN group and Control group the ANOVA test was performed. Level of significance was considered at <0.05 .

Results

Table 3: Demographic details of CYP group, CYP-SN group and control group

Demographic data	CYP Group (N = 12)	CYP-SN Group (N = 23)	Control Group (N = 17)
Age (Years)	46.58 ± 9.94	45.26 ± 8.95	43.23 ± 9.23
Male	6 (50%)	13 (56.52%)	8 (47.06%)
Female	6 (50%)	10 (43.48%)	9 (52.94%)

Table 4: Baseline characteristics of the participants

Lipid parameters	CYP Group (N = 12)	CYP-SN Group (N = 23)	Control Group (N = 17)
TC (mg/dl)	225.5 ± 38.02	203.22 ± 52.39	196.68 ± 41.38
TG (mg/dl)	193.33 ± 65.49	138.65 ± 82.42	169.54 ± 38.63
HDL (mg/dl)	48.75 ± 6.90	48.52 ± 2.98	45.87 ± 2.85
VLDL (mg/dl)	38.66 ± 13.09	27.71 ± 16.49	33.89 ± 7.74
LDL (mg/dl)	138.08 ± 29.67	126.98 ± 46.58	116.86 ± 40.55
TC-HDL Ratio (Ratio)	4.65 ± 0.64	4.19 ± 1.13	4.31 ± 0.93
LDL-HDL Ratio (Ratio)	2.86 ± 0.65	2.63 ± 1.02	2.57 ± 0.90

TC = Total Cholesterol; TG = Triglycerides; HDL = High density lipoprotein; VLDL = Very low density lipoprotein; LDL = Low density lipoprotein.

Demographic details and baseline characteristics of the participants

Table 3 revealed the demographic details of the participants in selected groups *i.e.* CYP group, CYP-SN group and Control group. The average age of the participants is 46.58, 45.26 and 43.23 for CYP group, CYP-SN group and Control group respectively. The percentage of male and female participants in the CYP group (Male-50%, Female-50%), CYP-SN group (Male-56.52%, Female-43.48%) and Control group (Male-47.06%, Female-52.94%) was also shown in Table 1. Moreover, the baseline characteristics of the participants were also postulated in the Table 4.

AYUSH YP group shows significant improvement on Cholesterol levels

As per Table 5, within-group analysis showed that in CYP Group, the common yoga protocol significantly reduces

Table 5: Showing changes in lipid profile in CYP group

Lipid parameters	Test condition	CYP Group (N = 12)			t-value	P-value
		Mean ± SD	95 % CI			
			Lower	Upper		
TC (mg/dl)	Pre test	225.5 ± 38.02	2.2381	28.4285	2.577	0.026
	Post test	210.16 ± 29.28				
TG (mg/dl)	Pre test	193.33 ± 65.49	-12.1093	27.2760	0.848	0.415
	Post test	185.75 ± 75.54				
HDL (mg/dl)	Pre test	48.75 ± 6.90	-0.7766	4.1100	1.501	0.161
	Post test	47.08 ± 6.68				
VLDL (mg/dl)	Pre test	38.66 ± 13.09	-2.4219	5.4552	0.848	0.415
	Post test	37.15 ± 15.10				
LDL (mg/dl)	Pre test	138.08 ± 29.67	-0.9207	25.2207	2.046	0.065
	Post test	125.93 ± 29.60				
TC-HDL Ratio (Ratio)	Pre test	4.65 ± 0.64	-0.20248	0.46248	0.861	0.408
	Post test	4.52 ± 0.75				
LDL-HDL Ratio (Ratio)	Pre test	2.86 ± 0.65	-0.17192	0.43025	0.944	0.365
	Post test	2.73 ± 0.79				

Data are expressed in mean, SD, t-value, CI and statistical significance. TC = Total Cholesterol; TG = Triglycerides; HDL = High density lipoprotein; VLDL = Very low density lipoprotein; LDL = Low density lipoprotein; CI = Confidence Interval; SD = Standard Deviation.

cholesterol after three months of intervention, from 225.5 ± 38.02 mg/dL to 210.16 ± 29.28 mg/dl with significant pre-post difference (p-value = 0.026). No significant changes were observed on other lipid parameters viz. in TG (p = 0.415), HDL (p = 0.161), LDL (p = 0.065), VLDL (p = 0.065),

TC-HDL Ratio (p = 0.408), LDL-HDL Ratio (p = 0.567) after three months of CYP practice. However, the mean improvement was exhibited in Triglycerides from 193.33 ± 65.49 to 185.75 ± 75.54 and LDL from 138.08 ± 29.67 to 125.93 ± 29.60 respectively.

Table 6: Showing changes in lipid profile in CYP-SN group

CYP-SN Group (N = 23)						
Lipid parameters	Test condition	Mean ± SD	95 % CI		t-value	P-value
			Lower	Upper		
TC (mg/dl)	Pre test	203.22 ± 52.39	-1.4789	21.4876	1.807	0.084
	Post test	193.21 ± 44.33				
TG (mg/dl)	Pre test	138.65 ± 82.42	-23.2601	8.5644	-0.958	0.349
	Post test	146 ± 67.33				
HDL (mg/dl)	Pre test	48.52 ± 2.98	-0.7633	1.8938	0.882	0.387
	Post test	47.95 ± 4.52				
VLDL (mg/dl)	Pre test	27.71 ± 16.49	-4.6643	1.6991	-0.966	0.344
	Post test	29.2 ± 13.46				
LDL (mg/dl)	Pre test	126.98 ± 46.58	-1.2892	22.2718	1.847	0.078
	Post test	116.49 ± 39.24				
TC-HDL Ratio (Ratio)	Pre test	4.19 ± 1.13	-0.176693	0.391041	0.783	0.442
	Post test	4.09 ± 1.03				
LDL-HDL Ratio (Ratio)	Pre test	2.63 ± 1.02	-0.11646	0.42863	1.18	0.248
	Post test	2.47 ± 0.90				

Data are expressed in mean, SD, t-value, CI and statistical significance. TC = Total Cholesterol; TG = Triglycerides; HDL = High density lipoprotein; VLDL = Very low density lipoprotein; LDL = Low density lipoprotein; CI = Confidence Interval; SD = Standard Deviation.

Table 7: Showing changes in lipid profile in Control group

Control Group (N = 17)						
Lipid parameters	Test condition	Mean ± SD	95 % CI		t-value	P-value
			Lower	Upper		
TC (mg/dl)	Pre test	196.68 ± 41.38	-9.4252	19.4958	0.738	0.471
	Post test	191.64 ± 36.43				
TG (mg/dl)	Pre test	169.53 ± 38.63	-67.9599	32.9128	-0.737	0.472
	Post test	187.05 ± 84.78				
HDL (mg/dl)	Pre test	45.87 ± 2.85	-0.7644	2.1526	1.009	0.328
	Post test	45.17 ± 2.87				
VLDL (mg/dl)	Pre test	33.89 ± 7.74	-13.4578	6.6578	-0.717	0.484
	Post test	37.29 ± 16.90				
LDL (mg/dl)	Pre test	116.86 ± 40.55	-0.9194	16.5311	1.897	0.076
	Post test	109.05 ± 37.97				
TC-HDL Ratio (Ratio)	Pre test	4.30 ± 0.93	-0.36889	0.44183	0.191	0.851
	Post test	4.27 ± 0.95				
LDL-HDL Ratio (Ratio)	Pre test	2.57 ± 0.90	-0.09853	0.37735	1.242	0.232
	Post test	2.43 ± 0.88				

Data are expressed in mean, SD, t-value, CI and statistical significance. TC = Total Cholesterol; TG = Triglycerides; HDL = High density lipoprotein; VLDL = Very low density lipoprotein; LDL = Low density lipoprotein; CI = Confidence Interval; SD = Standard Deviation.

No substantial changes were seen on lipid parameters in AYUSH SN group.

According to the results depicted in Table 6, in the CYP-SN group cholesterol ($p = 0.084$) TG ($p = 0.349$), HDL ($p = 0.387$), LDL ($p = 0.078$), VLDL ($p = 0.344$), TC-HDL Ratio ($p = 0.442$), LDL-HDL Ratio ($p = 0.192$) shows no significant changes after the CYP-SN practice. Although the non-significant amelioration on cholesterol (225.5 ± 38.02 to 210.16 ± 29.28) triglycerides (193.33 ± 65.49 to 185.75 ± 75.54) and LDL (138.08 ± 29.67 to 125.93 ± 29.60) levels were noticed in CYP-SN group. Whereas no changes were seen on HDL, VLDL, TC-HDL Ratio, LDL-HDL Ratio.

Statistically no significant differences were seen on lipid parameters on Control group

Based on the results exhibited in Table 7, the cholesterol ($p = 0.471$) TG ($p = 0.472$), HDL ($p = 0.328$), LDL ($p = 0.076$), VLDL ($p = 0.484$), TC-HDL Ratio ($p = 0.851$), LDL-HDL Ratio ($p = 0.232$) shows no significant differences at baseline and after three months in control group.

Although, the minimal decreasing trend in TC (196.68 ± 41.38 to 191.65 ± 36.43) and LDL (116.86 ± 40.55 to 109.06 ± 37.97) values whereas increasing trend in TG (169.54 ± 38.63 to 187.06 ± 84.78) values were observed in control group.

Table 8: Between group comparison for lipid profile in Control, CYP, and CYP-SN group

Lipid parameters	Test condition	Group Mean			Source of Variance	Sum of Squares	df	Mean Squares	F-value	P-value
		Control	CYP	CYP- SN						
TC (mg/dl)	Pre test	196.68	225.5	203.22	Between Group	6213.814	2	3106.907	1.468	0.240
		N = 17	N = 12	N = 23	Within Group	103720.964	49	2116.754		
	Post test	191.64	210.16	193.21	Between Group	2888.846	2	1444.423	0.958	0.391
		N = 17	N = 12	N = 23	Within Group	73917.462	49	1508.520		
TG (mg/dl)	Pre test	169.53	193.33	138.65	Between Group	25263.572	2	12631.786	2.807	0.070
		N = 17	N = 12	N = 23	Within Group	220544.103	49	4500.900		
	Post test	187.05	185.75	146	Between Group	21069.328	2	10534.664	1.860	0.167
		N = 17	N = 12	N = 23	Within Group	277553.191	49	5664.351		
HDL (mg/dl)	Pre test	45.87	48.75	48.52	Between Group	85.652	2	42.826	2.468	0.095
		N = 17	N = 12	N = 23	Within Group	850.244	49	17.352		
	Post test	45.17	47.08	47.95	Between Group	76.425	2	38.213	1.743	0.186
		N = 17	N = 12	N = 23	Within Group	1074.344	49	21.925		
VLDL (mg/dl)	Pre test	33.89	38.66	27.71	Between Group	1012.551	2	506.276	2.809	0.070
		N = 17	N = 12	N = 23	Within Group	8830.589	49	180.216		
	Post test	37.29	37.15	29.2	Between Group	828.161	2	414.081	1.832	0.171
		N = 17	N = 12	N = 23	Within Group	11074.739	49	226.015		
LDL (mg/dl)	Pre test	116.86	138.08	126.98	Between Group	3190.241	2	1595.121	0.933	0.400
		N = 17	N = 12	N = 23	Within Group	83748.202	49	1709.147		
	Post test	109.05	125.93	116.49	Between Group	2005.710	2	1002.855	0.738	0.483
		N = 17	N = 12	N = 23	Within Group	66592.237	49	1359.025		
TC-HDL Ratio (Ratio)	Pre test	4.30	4.65	4.19	Between Group	1.635	2	0.818	0.856	0.431
		N = 17	N = 12	N = 23	Within Group	46.824	49	0.956		
	Post test	4.27	4.52	4.09	Between Group	1.466	2	0.733	0.804	0.453
		N = 17	N = 12	N = 23	Within Group	44.676	49	0.912		
LDL-HDL Ratio (Ratio)	Pre test	2.57	2.86	2.63	Between Group	0.652	2	0.326	0.387	0.681
		N = 17	N = 12	N = 23	Within Group	41.226	49	0.841		
	Post test	2.43	2.73	2.47	Between Group	0.734	2	0.367	0.479	0.622
		N = 17	N = 12	N = 23	Within Group	37.507	49	0.765		

Data are expressed in statistical significance. TC = Total Cholesterol; TG = Triglycerides; HDL = High density lipoprotein; VLDL = Very low density lipoprotein; LDL = Low density lipoprotein; CI = Confidence Interval; SD = Standard Deviation.

No group differences noticed among CYP Group, CYP-SN group and Control group

The between the group differences were also analyzed in the present study and it was found that among CYP Group, CYP-SN group and Control group there was statistically no significant differences were found among the selected groups at pre and post levels (Table 8).

Discussion

The present study was designed to analyze the role of CYP and CYP-SN on the lipid profile of dyslipidemia subjects. Results of the investigation revealed that a three-month intervention resulted in elevation of HDL-C levels in the group that had undergone CYP as well as CYP-SN protocol. This implied benefits of Surya namaskar in modifying lipid profile, reflecting an improvement in dyslipidemia which is a condition with abnormally elevated levels of lipids in the blood.

It is of utmost importance to identify and address the dyslipidemia in initial stages as the progression can lead to atherosclerosis and advanced cardiovascular disease. Dyslipidemia also results in abnormalities in lipolysis, triglyceride metabolism and free fatty acid turnover. Chronic exposure to increased free fatty acids leads to impaired insulin secretion and thus leading to diabetes (16). Maintaining a healthy glycemic control is a major factor that can regulate the prevention of dyslipidemia and prevent major cardiovascular events (17). Moreover, Taliya et al. did a cross-sectional survey on the western U.P population (India), and they reported the rise in fasting blood sugar levels is related to the dysregulated lipid parameters (18). Nagarathna et al also pointed out the positive correlation of HbA1c with LDL, TC and LDL whereas negative correlation was found between the HbA1c and HDL Levels (14).

Earlier investigators have explored the impact of Yoga protocol on different medical conditions (12,13). Some of these studies exhibited a significant impact of yoga, whereas some showed promising but inconclusive results on different medical conditions. Moreover, few studies have investigated the effects of Yoga on subjects with the risk of CVD, i.e., dyslipidemia. That underscored the need and relevance of the present study for management of Dyslipidemia and prevention of related ailments such as diabetes and CVD.

A study of '40-days slow SN Yoga protocol' with T2DM patients reported significantly lower levels of LDL, VLDL, TG, TC but no significant difference was found in HDL values (19). Another study of '14-week SN protocol' with severe ischemic heart disease patients revealed an increase in HDL (20).

The results of the present investigation are supported by a study of diabetic patients (11,254 Indian adults in age range 20–70 years) in whom practicing Yoga protocol resulted in a significant alteration in lipid profile values of patients of both genders with high risk (≥ 60 on Indian diabetes risk score). In this nationwide rural and urban community-based randomized controlled trial, reduced serum TC, triglycerides, LDL and increased HDL were reported in Yoga group as compared to

the control group (21). Studies have shown that three months of practice of Yoga protocol, a significant percentage of diabetics with abnormal lipid levels reverted to normal levels of cholesterol (189.38 mg/dl) from the baseline (232.34 mg/dL) with an 18% reduction. A direct positive correlation was found between dyslipidemia and glycated hemoglobin (HbA1c), where the lipid levels increased as HbA1c increased (22). Concomitantly, studies have emphasized the therapeutic role of Yoga, resulting in significant elevation of HDL cholesterol and reduction of TC, TG, LDL and VLDL (17,18).

Findings of the present study revealed positive impact of yoga in patients with dyslipidemia. Yoga and Ayurveda which are traditional Indian sciences which put focus on healthy lifestyles and maintaining a healthy balance between body and mind functions. Though some of researchers have explored the impact of yoga in diabetes and CVD, but research on impact of yoga on Dyslipidemia is still nascent. There is a need to identify the factors which can influence the impact of yoga on patients with dyslipidemia.

Yoga asanas activate various enzymes which can further stimulate their substrates, leading to the reduction of LDL and TG. Yoga can alter lipid profile, owing to increased hepatic lipase and lipoprotein lipase. Yoga has been found to be helpful in equal body fat distribution and managing the central obesity leading to upregulation of insulin receptors and sensitivity and a change in the level of insulin to left with normalization of insulin glucagon ratio (23). Pranayama increases blood supply to muscles increasing the insulin receptor profile in muscles and increasing the uptake of glucose by the cells. This further reduces levels of blood sugar (24,25).

Researchers have tried to identify attributable factors in the effectiveness of exercise for lipid profiles. It was found that the physical activity lead to higher HDL levels and lowering the concentration of VLDL-C and TG (26–28). Therefore, HDL have an important part in managing cholesterol levels.

In line with studies exploring the changes in HDL and cholesterol brought by exercise, some investigators have studied the impact of yoga practices on cholesterol. The outcome of Yoga intervention in the present study are in accordance with earlier findings (29–35) indicating a significant decrease in variables of obesity like BMI, blood pressure and total lipids.

Studies have revealed that after 90 days of yoga intervention, significant reduction was observed in levels of serum total cholesterol in hypertensive patients, serum TG and LDL-C, and significant increase in levels of serum HDL-C (23). Others have suggested that yoga helps in stimulation of Carnitine Palmitoyl Transferase (CPT) system and sterol regulatory element binding proteins, thus impacting fatty acid metabolism (23,36).

Many recent Pharmacological interventions in treatment of dyslipidemia have focused on reduction of LDL-C and elevation of HDL-C. Reducing LDL-C has been a deciding factor in lowering the risk and management of atherosclerosis and cardiovascular health problems. The medications for treatment of dyslipidemia have shown promising results. Rosuvastatin (10–40 mg) has been found to decrease level of

LDL-C by 52–63%, and increasing levels of HDL-C by up to 14% and reducing the levels of TG by up to 28% (37).

A positive impact was found in 100T2DM subjects after three months Yoga intervention (13). Investigators also have reported decrease in mean value of TC i.e. 240.36 mg/dL (High) to 214.11 mg/dL (borderline) after Yoga intervention for four months in 158 Type 2 Diabetes and dyslipidemia patients when compared to treated group taking sulphonyl urea (38).

Yoga intervention can delay the dyslipidemia associated health problems. However, there is need to do extensive research on impact of yoga on different parameters of dyslipidemia. Further, more randomized controlled trials are required on different populations and locations to explore the potential impact of yoga on dyslipidemia. The results of the present investigation are in contradiction to a few studies (39,40) which reported that changes did not occurred all the parameters. They had reported that there was not significant result observed in patients with any family history of dyslipidemia after yoga intervention. This may be interpreted as, family history might not have any co-relationship in management of dyslipidemia in diabetic patient practising yoga intervention for short periods.

To conclude, yoga is a promising intervention in management and prevention of dyslipidemia. Besides the medication, regular yoga practice can improve not only physical health but mental well-being too.

Strength

This study was a randomized controlled trial and followed CONSORT guidelines that enhances its credibility.

Limitation

The sample size was reduced due to drop outs. Thus, in each group, the final sample was small.

The study duration is very less for the protocol to be fully effective in combination with low-intensity type training. Since the study was conducted in harsh winters in an in-person mode with an added fear of Covid-19 infection, many participants dropped out of the study. Effect of the Common yoga protocol and *Surya Namaskar* on dyslipidemia individuals was evaluated. Hence, specific yoga protocol for dyslipidemia individuals was not used and can be considered a limitation of the study.

Conclusion

Three-month CYP and CYP-SN resulted in increased HDL-C levels in the group that had undergone common yoga protocol as well as common yoga protocol along with *Surya Namaskar*, implying the benefits of *Surya Namaskar* in managing dyslipidemia. Enhanced intensity of *Surya Namaskar* can lead to more impactful dyslipidemia management.

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Authors' contribution

JA: Conceptualization of the study (Yoga Intervention)
 DS: Yoga instructor for the study and collected the Data
 HM: Yoga instructor for the study and collected the Data
 KM: Performed the Analysis, writing and editing
 YB: Wrote the draft
 RV: Writing – review and editing
 SJ: Design the study and writing, review and editing
 SA: Writing - reviewing and editing
 MG: Writing - reviewing and editing
 NK: Performed the Analysis and Writing
 JA: Writing - reviewing and editing
 GS: Reviewing and editing

Abbreviations

CVD	Cardiovascular diseases
CHD	Coronary Heart diseases
CKD	Chronic kidney disorder
AYUSH	Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homeopathy
SN	<i>Surya Namaskar</i>
CYP	Common Yoga Protocol
CYP-SN	Common Yoga Protocol
HDL-C	High-density Lipoprotein-Cholesterol
LDL-C	Low-density Lipoprotein-Cholesterol
VDL-C	Very low-density lipoprotein
TC	Total cholesterol
TG	Triglyceride
IEC	Institutional ethical committee

Ethical statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and Ethical clearance was taken from Haryana Yog council institutional ethical committee (EC/NEW/INST/2022/2489).

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Conflict of interest

The authors do not have any conflict of interest.

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