Nigerian Medical Journal
NIGERIA MEDICAL ASSOCIATION
Print ISSN 0300-1652, E-ISSN 2229-774X

Original Research

A study to compare and correlate the effect of a yogic lifestyle on Framingham, Q RISK 3, and WHO risk scores among high-risk cardiovascular subjects

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Abstract

Background: Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. Yoga is a low-cost, easily accessible lifestyle modification program that holds as an approach to decreasing cardiometabolic risk factors and increasing exercise self-efficacy among high-risk subjects. This study aimed to assess the impact of the yogic lifestyle (including diet) on cardiovascular risk scores by using the Framingham (FRS), QRISK3 score, and World Health Organization (WHO) CVD risk prediction charts at baseline, three months, and six months. The present study compares and correlates FRS, QRISK3, and WHO cardiovascular risk scores.

Methodology: The experimental interventional study was conducted among the high-risk population at RUHS College of Medical Sciences and Associated Group of Hospitals, Jaipur. Framingham risk Score, QRISK3 score, and WHO CVD risk prediction charts were used as a method of measurement for the outcome of interest at baseline, three months, and six months in the study and control group. Randomization and allocation in yoga and control groups were performed using computer-generated random numbers. The statistical analysis was done using advanced SPSS-22 software at significant level tests as $p \leq 0.05$, ensuring the highest level of accuracy. Data were analyzed using a one-way variance ANOVA test analysis at baseline, three, and six months. Pearson correlation analysis was done to compare different risk scores.

Results: Participants had a mean age of 48.43 ± 6.4 years. Baseline values (mean±SD) of FRS, Qrisk3, WHO were 24.59±10.15,28.59±10.11,15.71±6.07. After six months of yogic lifestyle, these values decreased significantly to 15.1±7.05, 20.09±7.08, and 13.85±4.96. The decrease in cardiovascular scores was statistically significant ($p<0.0001$), providing strong evidence for the effectiveness of the yogic lifestyle. Pearson correlation analysis results depict that FRS and Q risk 3 ($r=0.840$, $p<0.0001$), FRS and WHO risk chart ($r=0.768$, $p<0.0001$), Q risk3 and WHO risk chart ($r=0.778$, $p<0.0001$) have a statistically significant strong positive correlation.

Conclusion: This study's findings suggest that a 24-week yogic lifestyle intervention (including diet) significantly decreased FRS, Q RISK 3, and WHO CVD risk scores among high-risk subjects compared to the control group.

Keywords: Dietary intervention; Framingham; High-risk subjects; QRISK3 Score; WHO CVD risk chart; Yoga.

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How to cite: Saboo N, Roa A, Kacker S.- A study to compare and correlate the effect of a yogic lifestyle on Framingham, Q RISK 3, and WHO risk scores among high-risk cardiovascular subjects. Nig Med J 2024;65(6):911-924.https://doi.org/10.60787/nmj.v65i6.531

Quick Response Code:

Introduction:

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. CVDs include coronary heart disease, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis, and pulmonary embolism.[1]The results of the global burden of disease study state an age-standardized CVDs death rate of 272 per 100000 population in India, which is much higher than that of the global average of 235.[2]CVDs contributed to 28·1% of total deaths and 14·1% of total disability-adjusted life years (DALYs) compared with 15·2% and 6·9%, respectively in 1990.[3] About 80% of CVDs are caused by modifiable risk factors, i.e., hypertension, diabetes, hyperlipidemia, and body weight. Conventional risk factors such as hypertension, diabetes mellitus, dyslipidemia, smoking, and obesity were believed to be associated with the increased prevalence of CVDs in Indians.[4-5]

Estimating the risk of future cardiovascular events is essential for primary prevention of CVDs.[6] Assessment of cardiovascular risk is performed by determining the presence and severity of the significant cardiovascular risk factors and using risk algorithms to assess the overall cardiovascular risk.[7-8] Various risk assessment tools are available for this purpose, such as Framingham risk score (FRS)[9-10],prospectivecardiovascularMunster score (PROCAM)[8,] systemic coronary risk evaluation (SCORE)[8], World Health Organization cardiovascular disease risk prediction charts (WHO)[11], QRISK3[12], and 3rd iteration of joint British societies risk calculator (JBS)[13]. Different guidelines recommend different risk score calculators to assess the10-year cardiovascular risk and their management depending on their risk's cores. Primary prevention of CVD entails screening for cardiovascular risk in asymptomatic individuals and initiating risk reduction interventions among those at high risk to prevent cardiovascularevents.[5-9]

Kariuki et al, reported that interventions focusing on improving diet, physical activity, smoking cessation, and stress management have been associated with significant reductions in absolute CVD risk scores among adults in the high-risk CVD population.[14] Yoga is an ancient Indian practice focusing on mindfulness and physical flexibility, combining physical activity and meditation. Yoga has been increasingly popular yet has shown inconsistent benefits on cardiovascular disease (CVD) risk factors[15] Yadav et al[9] evaluated the efficacy of a short-term yoga-based lifestyle intervention program in lowering the FRS and estimated 10-year cardiovascular risk score. There was a significant reduction in FRS and an estimated 10-year cardiovascular risk after two weeks of intervention. Very few studies have evaluated the efficacy of lifestyle modification on cardiovascular risk scores by using only the FRS. There were no studies in which comparative analysis of yogic lifestyles on FRS, QRISK 3, and WHO risk scores was made. Thus, this study aimed to assess the impact of the yogic lifestyle (including diet) on CVD risk scores using the FRS, QRISK3 score, and the WHO CVD risk prediction charts and correlate these CVD risk scores among high-risk subjects. The secondary objective of this study was to increase awareness about cardiovascular risk factors and use lifestyle modification (Yoga and diet) as a tool for the primary prevention of cardiovascular disease and complications.

Method:

Study design and setting

Over one year, this experimental interventional study was conducted among high-risk subjects aged 40-70 in a tertiary health care center in Jaipur, Rajasthan. Institutional ethical approval (EC/P-13/2022) was obtained from the institutional ethics committee and registered with CTRI number: CTRI/2023/07/055233. Participants were divided into study and control groups following computer-generated randomization for this study. Assessments were made at baseline three, and after six months of yoga and diet interventions.

Recruitment of the participant

Study population

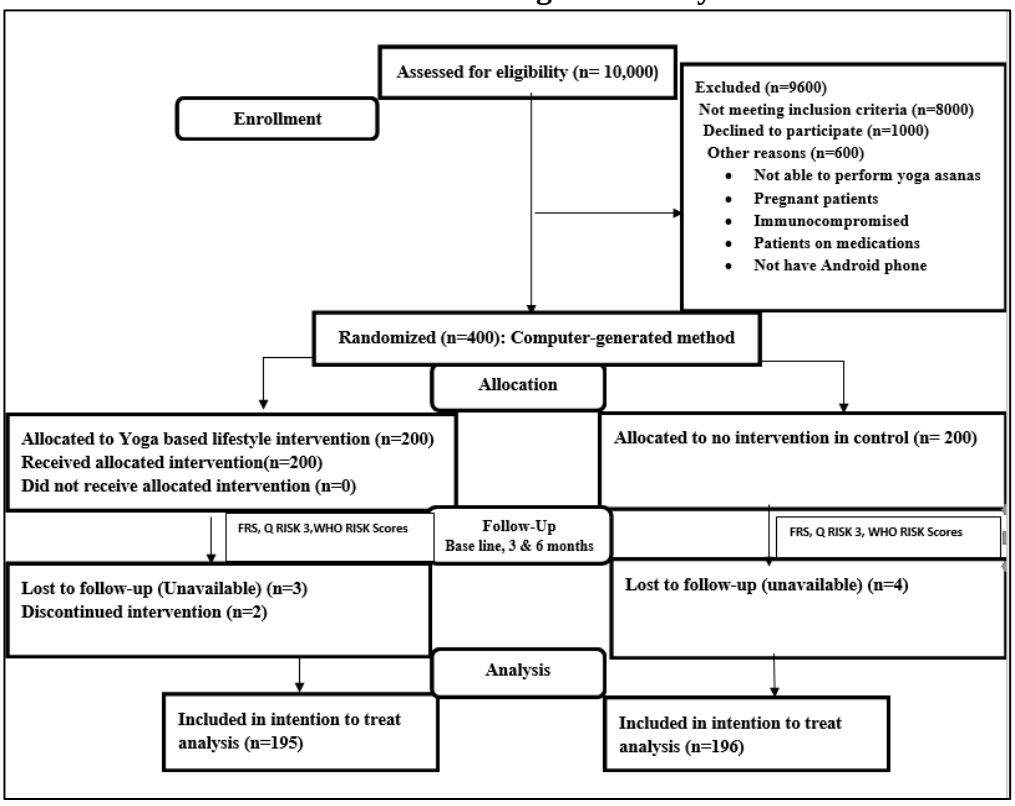
Aged 40-70 years were voluntarily recruited at outpatient departments via hospital-based advertisements, face-to-face contact, word-of-mouth, and flyers. The participants were recruited based on the following inclusion criteria: age between 40 and 70years, given written informed consent, having not practiced any form of yoga or exercise in the past three months, and subjects at high risk of CVDs. High-risk CVD subjects are defined as 10-year CVD risk scores of more than 20%, as assessed by Framingham, QRISK3, and the WHO risk prediction chart. Subjects with any previously diagnosed coronary artery disease (CAD) based on positive medical history (documented myocardial infarction (MI), angina pectoris, coronary artery bypass graft, ischemic changes on a conventional12-lead ECG which included ST-segment depression (Minnesota codes1-1-1 to 1-1-7) or Q-wave changes (Minnesota codes 4–1 to 4–2), pregnant, nursing mothers, and severe disabilities like kyphosis, scoliosis, and, osteoarthritis were excluded.

The sample size was calculated at a 95% confidence interval with an error of 0.05 and a prevalence of 14.1% [9]. Considering 10% attrition, the sample size was calculated as 198, which may be further rounded off to 200 subjects. Where $Z^2 = 3.96$ (the value of the standard variates at a given confidence interval, i.e., 95%), p = prevalence, q = 1-p, and e = allowable error.

Randomization and allocation:

A total of 10,000 subjects were screened. Out of 400 eligible individuals who met inclusion criteria, they were concealed and allocated by another person unaware of the study and randomly divided by computer-generated simple randomization into two groups: the study group (n=200) and the control group(n=200). Blinding of the participants was not possible due to the nature of the intervention. However, the outcome assessors were blinded. A total of 400 subjects enrolled on a rolling basis. (Figure;1)

Figure1: Study flowchart



Outcomes measured:

In this study, data collection of demographic and personal details such as age, gender, and contact number were recorded. Anthropometric parameters like weight, height, body mass index, and waist-hip ratio were measured. The subject's weight was measured on a calibrated digital machine (sec 111, beat XP) with the minimum of clothing nearest 0.1 kg. A standard stadiometer measured the subject's height to the nearest 0.1 cm. Body mass index (BMI) was calculated by using Quetelet's index weight (kg)/height $(m)^2$. Waist circumference (cm) was measured midway between the lowest rib and superior border of the iliac crest using an elastic measuring tape on the bare skin at the end of expiration and recorded to the nearest 0.1cm. Hip Circumference (in inches) was measured with the measuring tape to the nearest 0.1 cm at the widest point around the greater trochanter. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) pulse were estimated as the mean of the two measures in a sitting position after a 10-minute resting period with a validated automatic blood pressure monitor (Omron HEM 7120).

CVD risk score: In the present study, CVD risk scores were measured using FRS, QRISK 3, and WHO cardiovascular risk scores.

Framingham risk score (FRS): FRS was used to investigate the risk of cardiovascular disease. The FRS score was calculated based on the six coronary risk factors: age, gender, TC (mg/dL), HDL-cholesterol (mg/dL), systolic blood pressure (mm/Hg), and smoking habits. The cutoffs for calculating FRS were as follows: TC < 160, 160–199, 200–239, 240–279, and ≥ 280 mg/dL; for systolic blood pressure: < 120, 120–129, 130–139, 140–159, and ≥ 160 mmHg; and for HDL-C: < 40, 40–49, 50–59, and≥ 60 mg/dL. Ten-year risk in percentage was calculated by total points (1 point 6%, 2 points 8%, 3 points 10%, 4 points 12%, 5 points 16%, 6 points 20%, 7 points 25%, 10 points or more > 30%). Absolute CVD risk percentage over ten years is classified as low risk (< 10%), intermediate-risk (10–20%), and high-risk (> 20%).[9]

QRISK3 score: QRISK3 was a web calculator that can calculate the risk of developing cardiovascular disease over the next ten years. Q risk 3 includes age, sex, height, weight, ethnicity, smoking status, status of diabetes mellitus, family history of CVD, chronic kidney disease, atrial fibrillation, blood pressure treatment, migraine, rheumatoid arthritis, migraine, SLE, severe mental illness, atypical antipsychotic medication, use of steroid tablets, diagnosis/treatment of erectile dysfunction, Cholesterol/HDL ratio, SBP, and standard deviation of SBP. It is suitable for people who do not already have a diagnosis of coronary heart disease (including angina/heart attack) or stroke transient ischemic attack. It presents the average risk of people with the same risk factors. The calculator was available on the official website, and subjects were categorized per score, with a score of 20% or more considered highrisk.[12]

WHO risk charts: These charts indicate a 10-year risk of a fatal or non-fatal major cardiovascular event (myocardial infarction or stroke) according to age, sex, blood pressure, smoking status, total blood cholesterol, and presence or absence of diabetes mellitus[11]The WHO CVD risk prediction chart includes a wide range of genetic, socioeconomic, personal, physician-related, environmental, and healthcare delivery system-related factors that lead to CVD in most cases.[16-17] Targeting these risk variables in various high-risk groups and community settings has produced good outcomes.[18]

Biochemical parameters: All individuals were assessed by a screening lab. In study and control groups, the biochemical parameters of fasting blood glucose (FBG), glycated hemoglobin (HbA1C), and serum lipid profile were assessed at baseline, three, and six months. A fasting blood sample was taken. The FBG and HbA1C were assessed using the glucose oxidase-peroxidase (GOD) endpoint method[19] and the immunoturbidimetric method, respectively.[20] Serum lipid profiles included total cholesterol (TC)[21], triglyceride (TG), and high-density lipoprotein (HDL) were assessed by CHOD-PAP, GPO-PAP, and

phosphotungstic acid endpoint methods respectively[22]. Low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) were calculated using the Friedewald formula.[23]

Intervention and follow-up

Yoga intervention: The study group underwent a 24-week pretested, standardized, comprehensive yogic lifestyle intervention. The intervention was held at the yoga lab in RUHSCMS, Jaipur, for the first eight weeks. For the next 16 weeks, study participants were advised to continue the same yoga intervention in their homes. Video clips were shared to facilitate and guide home practices. A yoga instructor and investigators supervised yoga asanas. The 45-minute yoga sessions were conducted from 7:00 to 7.45 am every morning, six days per week, over six months under the direct supervision of a certified trained yoga instructor. The yoga instructor had obtained a two-year postgraduate (MA) in yoga therapy. The yoga instructor explained and demonstrated all the yoga asanas and postures. In yoga, protocol constitutes prayer, breathing practices, relaxation techniques, loosening exercises, different asanas, and meditation. (Table;1)

Table 1: Yoga Protocol[9]

S.NO	Posture	Duration
1.	Prayer	2 min
2.	Breathing Practices	6 min
3.	Relaxation Technique	5 min
4.	Loosening Exercises	3 min
5.	Yoga postures: Ardhakati chakrasana, Trikonasana, Vrikshana, Ardha chakrasana, Vakrasan,Ardhmatyasans, Makarasana (crocodile pose), Bhujangasana (cobra pose), Dhanurasana (bow pose),Naukasana	20 min
6.	Meditation	9 min
	Total duration	45 min

The study group received an instruction manual, images of yoga sequences, video clips, and diet plans. The participants were also provided with a diary to record and reinforce the recommended intervention at home. The subjects were instructed to record their daily food intake and yoga details in the diary.

Dietary intervention: All subjects received the same diet plan from a dietician based on Asian Indiannutritional guidelines.[24]In Asian Indian dietary guidelines, the nutrient composition is 50%–60% carbohydrates, <30% total fat, 10%–15% protein, 25–40g dietary fiber, and <5g salt.[25]Subjects were instructed to record their daily food intake in a diary. Dietary assessment was done using the food frequency questionnaire (FFQ)[26-27]

Adherence: Adherence to yoga sessions was assessed by daily attendance, which the yoga instructor recorded in an attendance register. Adherence was evaluated as the total number of sessions attended by the participant out of the total number of sessions conducted in the yoga lab in a month. Adherence was also ensured by reviewing the diaries when they came for follow-up every week. There was no modification in the intervention during the study period. Of the 400 participants, 9 participants were not included in the final analysis (5 from the study group and four from the control group)

Safety: Study participants were asked for an acute injury or other acute complaints during yoga practice. Most participants reported acute adverse effects associated with the musculoskeletal system, such as strains and sprains.

Statistical Analysis: The statistical analysis was done using SPSS-22 software tests of significance, considering the significance level as $p<0.05$. Data were analyzed using a one-way variance ANOVA test analysis at baseline, three, and six months. Pearson correlation analysis correlated FRS, Q risk 3, and WHO risk scores. The normality of the data was assessed using Kolmogorov- Smirnov tests. We used the intent to treat analysis with the last observation carried forward method to carry forward the previous observations of the dropouts.

Result:

Table 2: Distribution of Sociodemographic variables among the study population

Variables	Distribution	Study	Control
Total no of subjects		200	200
Sex	Male (M)	94	98
	Female (F)	106	102
Geographic Area	Rural	54	33
	Urban	146	167
Marital status	Married	191	179
	Unmarried	0	1
	Widow/widower	9	20
Socioeconomic status	Lower Middle	44	37
	Upper	14	29
	Lower	0	2
	Upper Lower	38	45
Yoga information	Yes	172	175
	No	28	25

Table 2 depicts the sociodemographic information of study participants. A total of subjects 400 recruited in the study and control groups with 200 each respectively. Most subjects were female, urban, married, and of upper-lower socioeconomic status.

Table 3: Comparison of different parameters at baseline and six months in high-risk CVD participants in control and study group

Variables	Groups	Baseline	Six months	Sign (2 tailed)
BMI (Kg/mt^2)	Control	28.93 ± 3.77	29.29 ± 3.7	0.000
	Study	29.43 ± 4.26	28.01 ± 3.98	0.000
	Control v/s Study p	0.218	0.001	
SBP (mm Hg)	Control	151.44±21.07	145.22 ± 14.51	0.000
	Study	149.77±15.59	131.33 ± 5.85	0.000
	Control v/s Study p	0.368	0.0001	
DBP (mm Hg)	Control	94.87 ± 12.06	91.85 ± 7.57	0.000
	Study	94.27 ± 9.2	84.92 ± 4.1	0.000
	Control v/s Study p	0.573	0.000	
SD SBP	Control	0.23 ± 0.52	0.04 ± 0.24	0.000
	Study	0.33 ± 0.54	0.07 ± 0.25	0.000
	Control v/s Study p	0.063	0.353	
FBG (mg/dl)	Control	123.22±43.19	101.9 ± 18.02	0.000
	Study	133.34±47.65	91.44 ± 13.14	0.000
	Control v/s Study p	0.026	0.0001	
HbA1C (%)	Control	6.83 ± 2.08	6.37 ± 1.71	0.000
	Study	7.51 ± 2.19	6.64 ± 4.33	0.003
	Control v/s Study p	0.001	0.48	
TC (mg/dl)	Control	220.23±41.59	227.07 ± 41.58	0.000
	Study	222.17±44.08	211.63 ± 40.4	0.000
	Control v/s Study p	0.651	0.000	
HDL (mg/dl)	Control	40.46 ± 7.19	40.69 ± 7.13	0.000

	Study	39.12 ± 8.31	41.98 ± 8.09	0.000
	Control v/s Study p	0.084	0.092	
Chl/HDL	Control	5.61 ± 1.43	5.74 ± 1.4	0.000
	Study	5.9 ± 1.75	5.21 ± 1.41	0.000
	Control v/s Study p	0.065	0.000	
LDL (mg/dl)	Control	138.79±38.41	145.38 ± 37.96	0.000
	Study	140.24±40.13	128.58 ± 35.84	0.000
	Control v/s Study p	0.712	0.000	
TG((mg/dl)	Control	203.26±53.53	211.74 ± 52.65	0.000
	Study	196.41±68.91	179.29 ± 62.94	0.000
	Control v/s Study p	0.267	0.000	

FFQ: Food Frequency Questionnaire; BMI: Body Mass Index; WHR: Waist-Hip Ratio; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; FBG: Fasting Blood Glucose; HbA1C: Glycosylated Haemoglobin; TC: Total Cholesterol; HDL: High Density Lipoprotein; Chl/HDL: Cholesterol-High Density Lipoprotein Cholesterol; LDL: Low-Density Lipoprotein; VLDL: Very Low-Density Lipoprotein

Table 3 depicts CVD variables at baseline and six months of yogic lifestyle (including diet) in this risk score outcome measured, i.e., Cholesterol/HDL ratio, SBP, and standard deviation of repeated blood pressure, height, and weight calculated as BMI. Q risk 3 scores and outcome measured variables were significantly decreased as compared to baseline after yogic lifestyle (including diet) in the study group. In the control group, the results were statistically nonsignificant.

Table 4: Descriptive statistics of Q RISK 3, WHO, and Framingham risk score

Risk score		**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**	
					Lower Bound	**Upper Bound**
QRISK 3 score/Baseline	Study	28.59	10.12	0.72	27.18	29.99
	Control	27.95	10.14	0.72	26.53	29.36
	Total	28.27	10.12	0.51	27.27	29.26
Three months	Study	23.99	8.33	0.59	22.83	25.15
	Control	27.00	9.54	0.67	25.67	28.33
	Total	25.50	9.07	0.45	24.60	26.39
Six months	Study	20.09	7.08	0.51	19.1	21.08
	Control	27.03	9.47	0.67	25.71	28.35

	Total	23.56	9.05	0.45	22.67	24.45
WHO Score/Baseline	Study	11.71	6.07	0.43	10.86	12.55
	Control	12.47	6.58	0.47	11.55	13.38
	Total	12.09	6.33	0.32	11.46	12.71
Three months	Study	9.85	4.98	0.35	9.16	10.54
	Control	12.12	6.27	0.44	11.24	12.99
	Total	10.98	5.76	0.29	10.42	11.55
Six months	Study	8.36	4.21	0.30	7.77	8.94
	Control	12.07	6.19	0.44	11.21	12.93
	Total	10.21	5.60	0.28	9.66	10.76
FRS Baseline	Study	14.61	11.23	0.79	13.05	16.18
	Control	16.07	12.24	0.87	14.36	17.78
	Total	15.34	11.75	0.59	14.19	16.50
Three months	Study	12.10	9.37	0.66	10.80	13.41
	Control	15.86	12.03	0.85	14.19	17.54
	Total	13.98	10.94	0.55	12.90	15.06
Six months	Study	10.19	8.1	0.57	9.06	11.32
	Control	15.83	11.95	0.85	14.17	17.50
	Total	13.01	10.58	0.53	11.97	14.05

Table 4 depicts descriptive Q risk 3, WHO, and Framingham risk score statistics. At baseline risk scores in the study group for QRISK3, FRS and WHO were 28.59, 14.61 and 11.71 respectively and 20.09, 10.19, 8.36 respectively after six months. At baseline risk scores in the control group, for QRISK3, FRS, and WHO were 27.95, 16.07, 12.47 respectively and 27.03, 15.83 and 12.07 after six months respectively. The result shows that after six months of yoga and diet intervention, results significantly decreased in the study group compared to the control group.

WHO; World Health Organization, FRS; Framingham risk score

Table 5: One-way analysis of variance of Q RISK 3, WHO, and FRS cardiovascular risk scores

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
QRISK Score	Between Groups	41.28	1	41.28	0.40	0.53
	Within Groups	40825.41	398	102.58		
	Total	40866.69	399			
Three months	Between Groups	907.52	1	907.52	11.32	0.001
	Within Groups	31898.09	398	80.15		
	Total	32805.60	399			
Six months	Between Groups	4810.12	1	4810.12	68.78	0.000
	Within Groups	27835.11	398	69.94		
	Total	32645.23	399			

WHO Score	Between Groups	57.76	1	57.76	1.44	0.23
	Within Groups	15947.35	398	40.07		
	Total	16005.11	399			
Three months	Between Groups	513.02	1	513.02	16.02	0.000
	Within Groups	12745.86	398	32.03		
	Total	13258.88	399			
Six months	Between Groups	1380.12	1	1380.12	49.36	0.000
	Within Groups	11128.82	398	27.96		
	Total	12508.94	399			
FRS Baseline	Between Groups	212.14	1	212.139	1.54	0.216
	Within Groups	54917.67	398	137.98		
	Total	55129.81	399			
3months	Between Groups	1413.76	1	1413.76	12.15	0.001
	Within Groups	46315.04	398	116.37		
	Total	47728.80	399			
Six months	Between Groups	3183.78	1	3183.79	30.58	0.000
	Within Groups	41438.56	398	104.12		
	Total	44622.34	399			

Table 5depicts the one-way analysis of variance of FRS, Q RISK 3, and WHO CVD risk scores at baseline, three months, and six months after a yogic lifestyle(including diet) in the study group. FRS, Q RISK 3, and WHO risk scores and variables are significantly decreased compared to baseline, three and six months after the yogic lifestyle (including diet). In the control group,the results were statistically nonsignificant.

Table 6: Correlation analysis of different cardiovascular risk scores

S.NO			**FRS**		**WHO**		**Q RISK 3**	
	Variables	**Groups**	**r value**	**p-value**	**r value**	**p-value**	**r value**	**p-value**
1.	**BMI**	Control	0.045	0.778	0.053	0.88	0.045	0.08
		Study	-0.02	0.74	-0.02	0.80	0.02	0.82
2.	**WHR**	Control	0.034	0.568	0.035	0.578	0.078	0.65
		Study	0.14	0.05	0.20	0.00	0.16	0.02
3.	**FBG**	Control	0.054	0.77	0.235	0.678	0.03	0.78
		Study	0.10	0.16	0.16	0.10	0.08	0.24
4.	**HbA1C**	Control	0.054	0.59	0.235	0.678	0.03	0.97
		Study	0.22	0.004	0.27	0.0001	0.200	0.00

5.	**HDL**	Control	0.074	0.89	0.235	0.678	0.04	0.88
		Study	-0.23	0.00	-0.06	0.36	-0.23	<0.0001
6.	**CHL/HDL**	Control	0.094	0.34	0.235	0.678	0.06	0.78
		Study	0.32	0.00	0.22	0.00	0.38	<0.0001
7.	**LDL**	Control	0.064	0.69	0.235	0.678	0.087	0.58
		Study	0.18	0.011	0.14	0.04	0.246	0.005
8.	**VLDL**	Control	0.07	0.568	0.235	0.678	0.045	0.87
		Study	0.24	0.00	0.31	0.00	0.25	<0.0001
9.	**TG**	Control	0.054	0.46	0.235	0.678	0.089	0.89
		Study	0.14	0.05	0.15	0.03	0.14	0.05
10.	**FRS**	Control	1	1	0.234	0.456	0.0345	0.775
		Study	1	1	0.768	<0.0001	0.840	<0.0001
11.	**Q Risk 3**	Control	0.432	0.345	0.117	0.673	1	1
		Study	0.768	<0.0001	0.778	<0.0001	1	1
12.	**WHO**	Control	0.213	0.456	1	1	0.113	0.656
		Study	0.840	<0.0001	1	1	0.778	<0.0001

Table 6 depicts a correlation analysis of Framingham, QRISK3, and WHO risk score. All risk scores were statistically and positively correlated to each other. Pearson correlation analysis results depict that after six months of yoga and diet intervention, FRS and Q risk 3 ($r=0.840$, $p<0.0001$), FRS and WHO risk chart ($r=0.768$, $p<0.0001$), Q risk 3 and WHO risk chart ($r=0.778$, $p<0.0001$) have a statistically significant strong positive correlation.

Discussion:

The present study evaluated the impact of the yogic lifestyle (including diet) on CVD risk scores by using the FRS, QRISK3 score, and WHO Risk charts and correlating these CVD risk scores among high-risk subjects.

Table 2 depicts the sociodemographic distribution of study participants. In a present study, the prevalence of high-risk CVD females (52%) was higher than males (48%). Sex is a potential risk factor in aging adults, given that older females are reported to be at a greater risk for CVD than age-matched men. However, in both men and women, the risks associated with CVD increase with age, and these correspond to an overall decline in sex hormones, primarily estrogen and testosterone.[28] In this present

study, the majority of study participants were in the age group of 40-49 years, which was similar to the study conducted by Andersson C et al.[29]

Table 3depicts a study group with a significant decrease in fasting blood glucose (FBG) and HbA1C after six months of yoga and diet intervention, similar to studies conducted by Cui Jet al,[30] Kacker S, et al.[31] Mechanism of decrease in glycaemic parameters after six month of yoga is due to deep breathing exercises during pranayama and muscular relaxation during asanas stimulate the pancreatic gland and pancreatic cells which enhances insulin secretion and regulation. Moreover, skeletal muscles can uptake glucose during exercise, which is independent of insulin. The impact of exercise is to stimulate and reshape the GLUT-4 carrier of the cell membrane from its intracellular storage location. Exercise training increases skeletal muscle mitochondria and GLUT4 protein expression, which is associated with improved skeletal muscle insulin sensitivity and whole-body metabolic health. Exercise-induced adaptations to skeletal muscle are essential to prevent and combat type 2 diabetes.[39]

In the present study, lipid profile TG, TC, LDL, TC/HDL were significantly decreased in the study group compared to the control group, similar to studies conducted by Cui Jet al,[30] Kacker S, et al,[31] Misra, et al,[32] and Cramer et al.[33] Chronic exposure to high levels of free fatty acids has been linked to decreased insulin secretion. Yoga practice may enhance lipid profiles due to increased hepatic and lipoprotein lipase. This would strengthen triglyceride absorption by fatty tissue and affect lipoprotein metabolism.[30-33]

Table 4 depicts descriptive statistics of Q RISK3, FRS, and WHO risk Scores in the study and control group. After six months of a yogic lifestyle, the Q RISK 3, FRS, and WHO CVD risk score significantly decreased compared to the control group. Results were similar to studies conducted by Yadav R, et al[9], and Pandey,et al[34] who reported a significant reduction in Framingham Risk Score and estimated 10-year cardiovascular risk following the short-term yoga-based intervention. The decrease in the risk score is most likely due to the substantial reduction in cardiovascular disease risk factors due to yoga and diet intervention as it activates vagal stimulation, which lowers inflammatory cytokines, improves baroreflex sensitivity, and lowers blood pressure and resting heart rate.[35-36]

The key strength of the present study is the use of the FRS, Q Risk 3, and WHO risk score estimated 10-year CVD risk reduction in assessing the efficacy of a six-month yogic lifestyle. Notably, the present study of high-risk CVD subjects included those who could be eligible participants for a yogic lifestyle for primary prevention of cardiovascular disease and complications. Previously published studies have indicated that compliance with super-vised yoga-based interventions was good.[35-38]

The main limitation of this study was the small sample size, which needs to be addressed in future studies to substantiate the long-term benefits of a yoga-based intervention. In addition, only the short-term benefits were evaluated in this study, and the results must be assessed in a long-term study. Another limitation was that subjects with only high risk enrolled in low to moderate risk were not included in the study. This study included only the Indian population. However, the findings can be extrapolated to other ethnic populations.

Conclusion:

After six months of a yogic lifestyle, cardiovascular risk scores for FRS, QRISK3, and WHO significantly decreased from baseline values. Comparative analysis of risk scores depicts that all risk scores decreased after six months of diet and yoga intervention. In the control group, the results did not decrease. All risk scores were positively and strongly correlated to each other. Increased awareness about cardiovascular risk factors and lifestyle modification (yoga and diet) among high-risk subjects can prevent the progression of cardiovascular disease and complications.

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