Original Article

# A Study to Evaluate the Effect of a Combined Approach of Yoga and Diet in High-risk Cardiovascular Subjects

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## Abstract

**Background:** Cardiovascular disease (CVD) is a group of disorders of the heart and blood vessels, including coronary heart disease, cerebrovascular disease, rheumatic heart disease, peripheral artery disease, congenital heart disease, deep vein thrombosis, and pulmonary embolism. **Aim:** The aim of this study was to assess cardiovascular risk factors and evaluate the effectiveness of combined approach of yoga and diet in reducing cardiovascular risk factors among high-risk subjects. **Materials and Methods:** This interventional study was conducted at RUHS College of Medical Sciences and Associated Hospitals, Jaipur, on the high-risk population of either sex in the age group of 40–70 years. QRISK3 web calculator was used as the method of measurement for outcome of interest. The combined approach of yoga intervention includes yogic asanas and pranayamas and dietary modification. **Results:** This study compared physiological parameters (blood pressure) and biochemical parameters (fasting blood sugar, glycosylated hemoglobin, lipid profile) at baseline, three months and six months after yoga and diet intervention in participants who were at high-risk of cardiovascular disease development in future and were found to be having significantly decreased systolic blood pressure ($P$=0.000), fasting blood glucose ($P$=0.000), glycosylated hemoglobin (HbA1C) ($P$=0.011), total cholesterol-high density lipoprotein ratio ($P$=0.000), low density lipoprotein ($P$=0.009), triglyceride ($P$=0.034), and QRISK3 Score ($P$=0.000) after combined approach of yoga and diet. **Conclusions:** This study concluded that the short-term combined approach of yoga-based life-style intervention and diet reduced cardiovascular risk factors in subjects at high-risk of developing cardiovascular disease.

**Keywords:** *Cardiovascular risk subjects, dietary intervention, QRISK3 Score, yoga*

## Introduction

Cardiovascular diseases (CVDs) refer to a variety of heart and blood vessel conditions and include coronary heart disease, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis, and pulmonary embolism.[1] CVD is becoming more prevalent in India, which is attributed to high lipoprotein levels as well as lifestyle risk factors.[2] A diet that is unbalanced and low in nutrients, along with a sedentary lifestyle and unhealthy behaviors, increases the chance of acquiring a number of chronic illnesses, including obesity, diabetes, and CVD.[3,4] The burden of CVD is influenced by several variables, including high blood pressure (BP), high cholesterol, dietary exposure, cigarette smoking, and obesity. Visceral and abdominal fat deposits have been linked to pro-inflammatory profiles, dyslipidemia, insulin resistance, and other metabolic syndrome components that support atherosclerosis, according to the available research.[5] The "Asian Indian Phenotype" refers to a combination of physiological (larger waist-to-hip and waist to height ratios signaling excess visceral adiposity), biochemical (insulin resistance, lower adiponectin, and higher C-reactive protein levels), and metabolic abnormalities (raised triglycerides [TG], low high-density lipoprotein [HDL] cholesterol). All these are more prevalent in individuals of South Asian origin and predispose this group to developing diabetes and premature CVD. In India, for both sex and all ages, the percentage of total prevalent cases of CVDs in the year 2019 was 5.24% of total prevalent cases.[6] Total number of people with CVD nearly doubled from 271 million in 1990 to 523 million in 2019, and deaths due to CVD climbed significantly from 12.1 million in 1990 to 18.6 million in 2019.[7] 32% of all fatalities worldwide in



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2019 were predicted to have been caused by CVDs, causing death of 17.9 million individuals.[1] The likelihood of developing hypertension and other cardiovascular disorders increases with a higher body mass index (BMI) and weight gain in childhood, which are typically connected to a poor diet.[8] Among vascular and metabolic abnormalities, hypertension, dyslipidemia, and raised fasting plasma glucose levels contributed most to the CVD disability adjusted life years in India.[9] CVD risk factors can be split into two categories: modifiable and nonmodifiable. Nonmodifiable CVD risk factors are those that cannot be changed. These include a person's age, gender, ethnicity, and family history. Modifiable CVD risk factors are those that can be reduced or controlled with altered behavior. By making certain lifestyle changes, people can lower their chances of developing CVD. High BP, high cholesterol, dietary exposures, cigarette use, and obesity all contribute to similar percentages of the burden of CVD, and all are modifiable risk factors. The first and most important step in managing individuals who need primary CVD prevention is estimating the risk of future cardiovascular events. Numerous risk assessment tools, including the of absolute Framingham risk Score (FRS),[10,11] the Prospective Cardiovascular Munster Score,[12] the Systemic Coronary Risk Evaluation,[13] the World Health Organization CVD Risk Prediction Charts,[14] the most recent version QRISK3,[15] and the third iteration of the Joint British Societies risk calculator, are available for this purpose.[16] QRISK3 risk score is validated and updated risk score which provides measure of absolute risk in general population. QRISK3 web calculators considers ethnicity also as an option with many additional risk factors like age (25-84), sex, smoking status which is assessed at 5 levels, diabetes status (type 1 or 2), angina or heart attack in first degree relative of < 60 years age, chronic kidney disease, atrial fibrillation, blood pressure treatment, migraine, rheumatoid arthritis, systemic lupus erythematosus, severe mental illness, on atypical antipsychotics, regular steroids, treatment of erectile dysfunction, Chl/HDL ratio, systolic blood pressure, and BMI.[15] Notable success in lowering preventable cardiovascular disease mortality has benefited the elderly (regular physical activity, weight control, eating healthy diet), but there is still considerable work to be done in the field of primary cardiovascular disease prevention, particularly for the people under the age of 65.[17] Physical inactivity is listed in numerous guidelines as a significant modifiable risk factor for developing CVD.[18] The recommendations make it abundantly clear that early lifestyle interventions are crucial for the prevention and management of CVD.[19] People who practice yoga on a regular and consistent basis lower their risk of high blood pressure, heart disease, strokes, and high plasma glucose levels, which helps them maintain a healthy weight.[20] Yoga is an age-old Indian discipline that combines physical, mental, and spiritual components, a beneficial form of activity. Yoga is a significant intervention for both primary and secondary prevention of CVDs since it is becoming more and more popular as a type of physical activity.[20] Innes and Vincent systemic study showed that yoga reduced metabolic risk factors including high BP and deranged lipid profile.[21] There are only a few studies that have estimated cardiovascular risk score using QRISK3 web calculator. Hence, the study was conducted for calculating risk scores with the help of QRISK3 web calculator in asymptomatic population to screen for the risk of developing CVD s and 6 months of combined approach of yoga and diet was given to study participants, i.e., who were at high risk of developing CVD.

## Materials and Methods

This study was conducted in the Department of Physiology and Medicine, Rajasthan University of Health Sciences College of Medical Sciences and Associated Hospitals, Jaipur, Rajasthan, over a period extending from November 2021 to November 2022. Approved CTRI number for the study was CTRI/2023/07/055233. Institutional ethical approval was taken from Rajasthan University Health Sciences-College of Medical Sciences Ethics Committee with Institutional Ethical Number RUHS- College of Medical Sciences/Ethics Comm./2021/70, and written informed consent was taken before data collection. Sample size was calculated 200 at 95% confidence interval and 5% Type I error and 80% power,[22] using mean and standard deviation formula $\frac{\left(z_{\frac{\alpha}{2}}+z\beta\right)^2 (SD)^2}{d^2}$. The height of the subject was measured to the nearest 0.1 cm using a standard stadiometer. Weight was measured to the nearest 0.1 kg using a standardized machine. BMI was calculated using Quetelet's index according to the following formula: BMI ($kg/m^2$) = weight in kilograms ÷ (height in meters)$^2$. Waist circumference was measured midway between the lowest rib and superior border of the iliac crest using inelastic measuring tape on the bare skin at the end of expiration and recorded to the nearest 0.1 cm. Hip circumference was measured with the measuring tape to the nearest 0.1 cm at the widest point around the greater trochanter. BP was recorded of all subjects in sitting position on the right arm with "Crystal Care Aneroid sphygmomanometer." Hypertension was defined as BP higher than 140/90 mmHg according to the Joint National Committee criteria VIII.[23] Serum Total Cholesterol by Cholesterol oxidase-peroxidase (CHOD-POD) enzymatic colorimetric assay, Serum High Density Lipoprotein-Cholesterol by accelerator selective detergent method, Serum Low Density Lipoprotein-Cholesterol and Very Low Density Lipoprotein-Cholesterol calculated using the formula of Fried Wald and Levy Serum Triglyceride by Glycerol phosphate oxidase(GPO-PAP) enzymatic colorimetric assay.[24-26] Fasting blood glucose (FBG) by glucose oxidase-peroxidase, endpoint method,[27] and glycosylated hemoglobin (HbA1C) by

HbA1c by immunoturbidimetric method were estimated using a commercially available kit in automated analyzer. A total of 11,150 subjects were screened out of which 400 were recruited, 200 were study participants and 200 were in the control group. A total of 11,150 subjects were screened to achieve the required sample size. Study and control group participants recruited through analyzing inclusion criteria (age 40-70 years, not practicing yoga in past three months, QRISK3 score >20%)[15] and exclusion criteria (previously diagnosed coronary artery disease, pregnant and nursing mothers, subjects with disabilities) by random sampling and the data of required parameters was collected. After collecting the data, CVD risk score was calculated by QRISK3 web calculator[15] and study participants who were at high risk of CVD were given six months of combined approach of yoga intervention[28] as mentioned in Table 1 (which included various postures (asanas) and pranayama) by certified yoga instructor and dietary intervention based on a diet chart planned by a certified dietician mentioned in Table 2. Yoga was performed for 6 days a week for 45 min/day for 6 months and included asanas like Ardhakati Chakrasana, Ardha Chakrasana, Vrikshana, Shitali, and Bhramari over a period of 6 months. Control group participants were not given any kind of intervention. CVD Risk assessment was done again after three and six months of intervention in study participants by QRISK3 web calculator and in the control group participants without any intervention. Subjects were asked to report if they experience any side effects while performing yoga, like palpitation, anxiety, pain and soreness, muscle injury, etc. Yoga for them was suspended for a week and routine physical examination and blood investigations were done. For home practices, yoga protocol video was provided to each and every subject. To evaluate compliance, daily messaging checks and weekly Google web meetings were done with yoga instructor as well as study participants. All the data pertaining to the research (including the medical history, medication history, physical examination, and biochemical parameters like FBG, HbA1C, and lipid profile) were entered into Microsoft Excel 2019 and were analyzed with help of IBM SPSS Statistics V21.0 software. SPSS (Statistical Package for the Social Sciences), also known as IBM (International Business Machines Corporation) SPSS Statistics, is a software package used for the analysis of statistical data and tests of significance considering level of significance as $P < 0.05$. Data were analyzed using Student's paired *t*-test.

**Table 1: Yoga protocol**

| Asanas and pranayama | Rounds | Duration (min) |
|---|---|---|
| Starting prayer | | 2 |
| Breathing practices | 30 | 6 |
| Hands stretch breathing | 10 | 2 |
| Ankle stretch breathing | 10 | 1 |
| Tiger breathing | 5 | 1 |
| Straight leg raise breathing (both legs) | 5 | 2 |
| Instant relaxation technique | | 1 |
| Loosening exercises | 60 | 3 |
| Slow jogging/drill walking | 50 | 2 |
| Twisting | 10 | 1 |
| Quick relaxation techniques | | 3 |
| Yogasanas | | |
| Standing | | 5 |
| Ardhakati chakrasana | | 1 |
| Ardha chakrasana | | 1 |
| Vrikshana | | 1 |
| Trikonasana | | 2 |
| Sitting | | 2 |
| Vakrasana | | 1 |
| Ardha-matsyendrasana | | 1 |
| Deep relaxation technique | | 7 |
| Pranayama | 30 | 8 |
| Sectional breathing | | 3 |
| Nadisuddi pranayama | 12 | 2 |
| Shitali/sitkari | 9 | 2 |
| Bhramari | 9 | 1 |
| Meditation | | 8 |
| Om meditation | | |
| Total time | | 45 |

**Table 2: Daily diet plan for the study group**

| MEAL | DIET |
|---|---|
| Early morning | 1 cup tea or coffee, 2 pieces marialite/digestive/ nutritive choice |
| Breakfast | 1 glass milk, 1 bowl veg poha/upma/daliya/sewaiyan/ oats or 2–3 pcs idli + chutney/2 pcs uttapam + chutney or 1 chapati + 1 bowl vegetable, 5 almonds, 2 walnuts (soaked overnight) |
| Mid-morning | 1 glass buttermilk/coconut water/lemon water, 1 seasonal fruit |
| Lunch | 1 big bowl salad or soup, 2 missi chapati, 1 bowl dahi or veg raita, 2 bowl seasonal vegetable (less of oil) |
| Evening tea | 1 cup tea or coffee, 1 bowl roasted chana chaat/ sprout, chaat (add lots of salad in it) |
| Dinner | 1 big bowl salad soup, 2 chapati, 1 bowl dal, 2 bowl seasonal vegetable (less of oil) |

## Results

In our study, total 400 study participants were enrolled, out of which 200 (50%) were study participants and 200 (50%) were control. There were 94 male (23.5%) and 106 female (26.5%) study participants, and in the control group, there were 98 male (24.5%) and 102 female (25.5%) participants. In this study, 235 (58.75%) subjects were of age group 40–49 years, 84 (21%) of age group 50–59 years, and 81 (20.25%) in age group 60–70 years.

Figure 1 shows the distribution of study participants according to their age group. One hundred and twenty-seven (63.5%) study participants were in the age group of 40–49 years, 46 (23%) in the age group

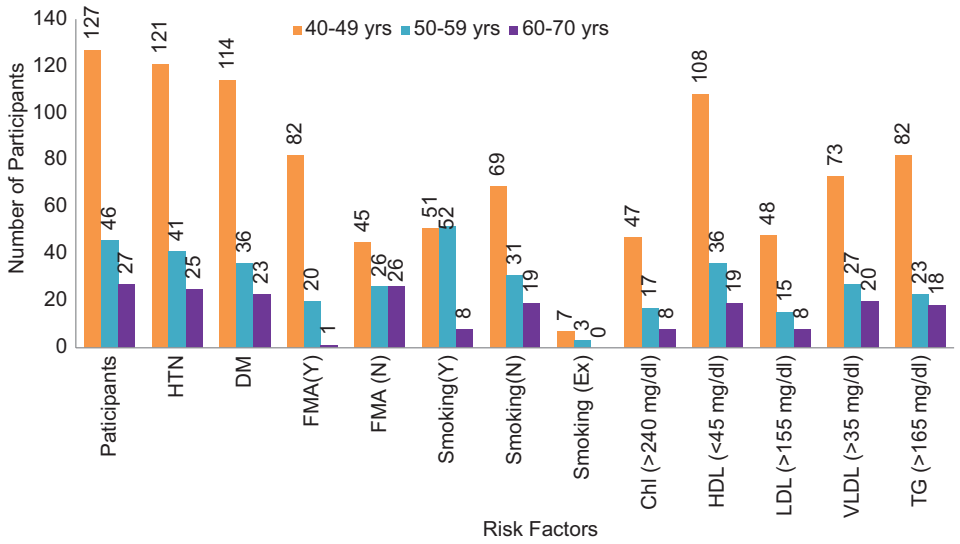


**Figure 1: Distribution of study group participants and risk factors according to age group. HTN: Hypertensive, DM: Diabetic, FMA (Y): Family history of angina (Yes), FMA (N): Family history of angina (No), Smoking (Ex): Ex Smokers (Used to smoke in past), Chl: Total Cholesterol, HDL: High Density Lipoprotein, LDL: Low Density Lipoprotein, VLDL: Very Low-Density Lipoprotein, TG: Triglycerides**

of 50–59 years, and 27 (13.5%) in the age group of 60–70 years. Majority of hypertensive study participants were in the age group of 40–49 years, i.e., 65% ($n$ = 121), whereas 20.5% ($n$ = 41) in the age group of 50–59 years and 12.5%[25] in the age group 60–70 years. In the age group of 40–49 years, 57% ($n$ = 114) study participants were diabetic and 18% ($n$ = 36) and 11.5% ($n$ = 23) were in the age group of 50–59 years and 60–70 years, respectively. Study participants having a family history of angina in first-degree relatives below age of 60 years were majorly present in age group of 40–49 years, i.e., 41% ($n$ = 82). 25.5% ($n$ = 51) of study participants were smokers and in the age group of 40–49 years, 6% ($n$ = 12) were in the age group of 50–59 years and 4% ($n$ = 8) in the age group of 60–70 years. High level of TC (>240 mg/dL) was present in 47 (23.5%) study participants in the age group of 40–49 years, 17 (8.5%) study participants in the age group of 50–59 years, and 8 (4%) study participants in the age group of 60–70 years. Low levels of HDL (<45 mg/dL) were present in 163 study participants out of which majority (54%, $n$ = 108) of study participants were in the age group of 40–49 years.

### Things to remember

- Avoid excessive consumption of maida and refined flour
- Use whole pulses or chilke wali pulses to increase the fiber content
- Use Double toned milk to reduce the fat content
- Avoid excessive intake of Aloo, Jameenkand, Arbi, and Shakarkandi
- Avoid excessive consumption of Mango, Banana, chikoo, lichi, grapes, and fruit juices because of high fructose content
- Avoid extra consumption of chocolates, cakes, pastries, bakery items, cold drinks, packed juices etc., (diabetic patients must avoid sugar and sweets totally)
- Oil and fats: 10–15 mL/day
- Avoid excessive consumption of fried items
- Keep changing oil every month like sunflower, safflower, canola. Rice bran, mustard oil to fulfill the body's requirement of essential fatty acids
- Fluids/Water: Around 3 L/day
- Eat less salt in routine.

Table 3 shows that there was a significant difference in calorie intake (food frequency questionnaire) after 6 months in study group and control. Significant differences were seen in following parameters (weight, BMI, waist circumference, hip circumferences, SBP, and diastolic BP [DBP]).

Table 4 shows that there was a significant decrease in FBG, TC, HDL, Chl/HDL ratio, LDL, and TG, and QRISK 3 score at 6$^{th}$ month in study and control group.

## Discussion

The present study was conducted in the Department of Physiology and Medicine, Rajasthan University of Health Sciences College of Medical Sciences and Associated Hospitals, Jaipur, Rajasthan, to evaluate the impact of yoga lifestyle in reducing cardiovascular risk in high-risk study group participants with the primary objective to assess effectiveness of combined approach of yoga intervention (which includes various postures (asanas), pranayama), and dietary modification on individual CVD risk factors (hypertension, diabetes, overweight, obese, dyslipidemia) in adults (40–70 years) at high risk of CVD.

In this study, a significant reduction in BMI was observed after 6 months in the study group compared to the control group. The study findings were consistent with studies

**Table 3: Comparison of different parameters at baseline, three months, and six months in high-risk cardiovascular disease study participants of study group (using ANOVA)**

| Study | Mean±SD | | | *F* | Significant (two-tailed) |
|---|---|---|---|---|---|
| | Baseline (*n*=200) | 3 months (*n*=200) | 6 months (*n*=200) | | |
| FFQ (kcal) | 2543.95±695.42 | 2251.52±564.29 | 2064.27±570.34 | 10.21 | <0.001 |
| Weight (kg) | 76.21±11.46 | 74.77±11.24 | 72.64±10.89 | 207.69 | 0.006 |
| BMI (kg/m$^2$) | 29.43±4.26 | 28.86±4.12 | 28.01±3.98 | 109.61 | 0.003 |
| Waist (cm) | 106.74±10.54 | 105.62±10.21 | 103.77±10.01 | 160.37 | 0.014 |
| Hip (cm) | 107.05±11.01 | 106.2±10.9 | 104.53±10.68 | 149.06 | 0.063 |
| WHR | 1±0.03 | 1±0 | 1±0 | 3.42 | 0.773 |
| SBP (mmHg) | 149.77±15.59 | 138.45±9.82 | 131.33±5.85 | 79.06 | <0.001 |
| DBP (mmHg) | 94.27±9.2 | 89.44±5.52 | 84.92±4.1 | 39.70 | <0.001 |
| FBG (gm/dL) | 133.34±47.65 | 102.43±23.02 | 91.44±13.14 | 52.87 | <0.001 |
| HbA1C (%) | 7.51±2.19 | 6.9±1.81 | 6.64±4.33 | 1.67 | 0.011 |
| TC (mg/dL) | 222.17±44.08 | 217.62±42.18 | 211.63±40.4 | 55.97 | 0.044 |
| HDL (mg/dL) | 39.12±8.31 | 40.32±8.12 | 41.98±8.09 | 127.08 | 0.002 |
| Cholesterol/HDL | 5.9±1.75 | 5.6±1.59 | 5.21±1.41 | 30.54 | <0.001 |
| LDL (mg/dL) | 140.24±40.13 | 135.28±37.83 | 128.58±35.84 | 66.17 | 0.009 |
| VLDL (mg/dL) | 42.78±16.9 | 42±16.77 | 41.05±16.62 | 52.79 | 0.586 |
| TG (mg/dL) | 196.41±68.91 | 188.93±65.75 | 179.29±62.94 | 63.51 | 0.034 |
| QRISK 3 score (%) | 28.59±10.15 | 24±8.35 | 20.1±7.05 | 81.04 | <0.001 |

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 hemoglobin, TC: Total cholesterol, HDL: High density lipoprotein, LDL: Low-density lipoprotein, VLDL: Very LDL, SD: Standard deviation, TG: Triglyceride

**Table 4: Comparison of different parameters at baseline, three months, and six months in high-risk cardiovascular disease study participants of control group (using ANOVA)**

| Control | Mean±SD | | | *F* | Significant (two-tailed) |
|---|---|---|---|---|---|
| | Baseline (*n*=200) | 3 months (*n*=200) | 6 months (*n*=200) | | |
| FFQ (kcal) | 2433.17±808.9 | 2379.23±849.85 | 2531±755.76 | 1.67 | 0.162 |
| Weight (kg) | 75.15±10.35 | 75.51±10.25 | 76.07±10.15 | 23.72 | 0.665 |
| BMI (kg/m$^2$) | 28.93±3.77 | 29.08±3.74 | 29.29±3.7 | 11.76 | 0.652 |
| Waist (cm) | 105.37±10.3 | 105.7±10.26 | 106.12±10.23 | 15.42 | 0.765 |
| Hip (cm) | 106.7±11.02 | 106.98±11.11 | 107.34±11.16 | 8.73 | 0.846 |
| WHR | 0.99±0.05 | 0.99±0.05 | 0.99±0.05 | 0.311 | 0.966 |
| SBP (mmHg) | 151.44±21.07 | 146.75±14.82 | 145.22±14.51 | 13.67 | 0.001 |
| DBP (mmHg) | 94.87±12.06 | 93.95±8.05 | 91.85±7.57 | 4.38 | 0.005 |
| FBG (gm/dL) | 123.22±43.19 | 107.81±22.99 | 101.9±18.02 | 17.14 | <0.001 |
| HbA1C (%) | 6.83±2.08 | 6.59±1.84 | 6.37±1.71 | 9.97 | 0.045 |
| TC (mg/dL) | 220.23±41.59 | 223.49±41.47 | 227.07±41.58 | 45.30 | 0.260 |
| HDL (mg/dL) | 40.46±7.19 | 40.59±7.2 | 40.69±7.13 | 4.08 | 0.934 |
| Cholesterol/HDL | 5.61±1.43 | 5.67±1.41 | 5.74±1.4 | 3.97 | 0.536 |
| LDL (mg/dL) | 138.79±38.41 | 141.86±38.04 | 145.38±37.96 | 42.81 | 0.226 |
| VLDL (mg/dL) | 40.98±17.17 | 41±17.13 | 41.02±17.14 | 0.34 | 1.000 |
| TG (mg/dL) | 203.26±53.53 | 207.7±53.19 | 211.74±52.65 | 45.47 | 0.281 |
| QRISK 3 score (%) | 27.94±10.14 | 27±9.54 | 27.03±9.47 | 8.166 | 0.575 |

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 hemoglobin, TC: Total cholesterol, HDL: High density lipoprotein, LDL: Low-density lipoprotein, VLDL: Very LDL, SD: Standard deviation, TG: Triglyceride

conducted by Seo *et al*.[29] and Chauhan *et al*.,[30] which reported that after yoga training, body weight, and BMI, were significantly decreased. The decrease in body weight and BMI in the yoga group may be due to increase in fat free mass and basal metabolic rate (BMR) following yoga as yoga asana provides an alternative option for increasing physical activity levels required to improve body composition and BMR in obese.[29-30]

In the present study, there was a significant decrease in SBP and DBP after 3 and 6 months in the study group compared to the control group similar to studies conducted by Deepa *et al*.,[31] Chauhan *et al*.,[30] and Cade *et al*.,[32] who

reported that there was a significant reduction in SBP and DBP after 1 month of yoga intervention. The mechanism of action of decrease in SBP and DBP is due to decrease in stress and a modification of baroreceptors sensitivity and parasympathetic tone from the effect of yoga. Yoga causes vagal stimulation, which lowers inflammatory cytokines, improves baroreflex sensitivity, and lowers BP and resting heart rate.[21,33-36]

The present study showed significant decrease in fasting blood glucose (FBG) and HbA1C after six month of yoga and diet intervention which is similar to studies conducted by Cui J *et al*,[37] Kacker S *et al*.[38] Mechanism of decrease in FBG, HbA1C after six months of yoga intervention is due to the effect of yoga practice which enhances insulin secretion and regulation as deep breathing exercises during pranayama and muscular relaxation during asanas stimulate the pancreatic gland and pancreatic cells. Moreover, skeletal muscles have great ability in glucose uptake during exercise which is independent of insulin. Impact of exercise is to stimulate and reshape the GLUT-4 carrier of cell membrane from their intracellular storage location. Exercise training results in increased skeletal muscle mitochondria and GLUT4 protein expression, which are 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 this study triglyceride, total cholesterol, low density lipoprotein, total cholesterol to high density lipoprotein ratio were significantly decreased in study group compared to control group, which was similar to studies conducted by Cui J *et al*,[37] Kacker S *et al*,[38] Misra *et al*,[39] Cramer *et al*.[40] In cases of insulin resistance, dyslipidemia is typically linked with problems in lipolysis, triglyceride metabolism, and free fatty acid turnover. Diabetes is hypothesized to cause impaired lipoprotein lipase and increased hepatic lipase activity as a result of insulin resistance. 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 lipase and lipoprotein lipase. This would enhance triglyceride absorption by adipose tissue and have an effect on lipoprotein metabolism.[37-40]

In this study, there was a significant difference in the QRISK3 score at 3 and 6 months between study and control group. A study which was conducted by Yadav *et al*.[22] reported that there was a significant reduction in FRS and estimated 10-year cardiovascular risk following the short-term yoga-based intervention. The decrease in the risk score is due to the significant decrease in the risk factors of CVD due to yoga and diet intervention as it activates vagal stimulation, which lowers inflammatory cytokines, improves baroreflex sensitivity, and lowers BP and resting heart rate.[21,33-36]

The various postures during yoga practice help to improve the sensitivity of β-cells to glucose, thereby improving insulin secretion, and increase the blood supply to the muscle and muscle relaxation, thereby improving glucose uptake. Improvements in hormonal homeostasis also improve glycemic control in people with diabetes mellitus.[41]

### Limitation

To corroborate our present study findings, we need to conduct a large sample size study. In the present study, due to time constraints, follow-up could not be done. Therefore, a follow-up of the study participants should be done to see the cardiac events. Long-term interventional studies to see the effectiveness of yoga on CVD risk factors and examine the impact of lifestyle changes on the primary prevention of the disease.

## Conclusions

In this study, a significant difference was also observed in physiological (BP and pulse) and biochemical parameters such as systolic and DBP and FBG, glycosylated hemoglobin, TC, Chl/HDL, LDL, VLDL, triglyceride, and creatinine, respectively, from baseline to 6 months in study group. In our study, we have observed that QRISK3 risk score showed a significant decrease after three and 6 months of yoga and diet intervention.

The study suggests that such lifestyle modification intervention of combined approach of yoga and diet are beneficial for people especially those who are at high risk of developing CVD and to avert future cardiovascular related morbidity and mortality.

### Ethical statement

The study was approved by the institutional Ethics Committee of RUHS College of Medical Sciences, Jaipur, Rajasthan, letter no. RUHS-CMS/Ethics/Comm./2021/70 dated 29/09/2021.

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### Conflicts of interest

There are no conflicts of interest.

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