

Clinically relevant weight loss and related outcomes following nine months of yoga or nutritional advice: a comparative controlled trial

Shirley Telles¹, PhD; Sachin Kumar Sharma², PhD; Ankur Kumar³, MA; Acharya Balkrishna⁴, DLitt

1,2,3,4. Patanjali Research Foundation, Haridwar, Uttarakhand, India

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Abstract

Objectives: The study aimed to compare the proportion of obese adults achieving weight loss of (i) five percent or more, (ii) three to five percent, and (iii) less than three percent in yoga and nutritional advice groups at three, six and nine months.

Material and Methods: One-hundred and seventy-three obese adults of both genders in a yoga group (YG) were compared with 147 adults in a nutritional advice group (NAG). Both YG and NAG were supervised each week, while YG practiced postures, breathing practices and guided relaxation, NAG received lectures on nutrition. Assessments were at baseline, 3, 6 and 9 months. Data were analyzed with (i) χ^2 test and (ii) GLMM with Bonferroni adjusted *post-hoc* comparisons.

Results: A higher number of obese adults achieved a weight loss of more than five percent in YG compared to NAG at three, six, and nine months follow-ups (χ^2 test, $p < 0.05$; Cramer's $V > 0.10$). At nine months, both groups decreased BMI, waist circumference, hip circumference, abdominal volume index, body roundness index, conicity index, and body shape index ($p_{adj} < 0.05$; in all cases). YG alone decreased SAD, triglycerides, and fasting blood glucose; and increased HDL and quality of life (QoL).

Conclusions: Yoga is more effective in reducing weight loss of more than five percent compared to nutritional advice at different times of follow-up in obese persons. Both yoga and nutritional advice reduce anthropometric measures and indices in the obese, however, with yoga the changes in biochemistry and QoL may sustain health and weight loss in the obese.

Keywords: obesity, anthropometry, anthropometric indices, risk of disease, yoga, nutritional advice, biochemistry, quality of life.

Introduction

Globally inappropriate nutrition as well as a sedentary lifestyle has contributed to weight gain.¹ Hence physical activity is medically recommended as an important strategy to manage non-morbid obesity.² However,

overweight and obese individuals often find it physically challenging to follow standard exercise regimens.³ This has led to investigating alternative forms of exercise, including yoga for weight regulation.^{4, 5} A systematic review and meta-analysis

assessed the effects of yoga for weight related outcomes in overweight and obese persons assessed in thirty randomized controlled trials with a total of 2,173 participants reviewed from Medline, Scopus, and the Cochrane Library bibliographic databases.⁵ Despite methodological drawbacks in the trials reviewed the authors concluded that yoga can be considered a safe and effective intervention to reduce the BMI in overweight and obese individuals.⁵

Previously, a pilot study on twenty six females with central obesity who received three months of yoga or nutritional advice showed that the group average reduction in body mass index with nutritional advice was 1.6 percent and with yoga the reduction was 3.3 percent with reduced cardiovascular risk factors in both groups.⁶ A weight loss equal to or exceeding five percent is known to improve health outcomes and is considered a standard goal in weight loss interventions.^{7, 8}

Also, an expert panel of the American College of Cardiology (ACC) and the American Heart Association (AHA) reported that sustained weight loss between three to five percent of body weight may lead to clinically meaningful reductions in certain cardiovascular risk factors; larger weight losses produce greater benefits.²

Hence the present study was conducted following the pilot study cited above⁶ on a larger sample of obese persons of both genders who received yoga or nutritional advice and who were followed up at three, six and nine months of the two interventions. The primary end point was the proportion of patients achieving weight loss of (i) five percent or more, (ii) three to five percent, (iii) less than three percent in both groups at three, six and nine months. In addition, anthropometric measures, serum lipid profile, blood glucose and quality of life were assessed in both groups at these time points.

Materials and Methods

Participants

Three hundred and twenty persons, of both sexes (F:M=186:134; 20-59 years of age), with obesity based on the definition of obesity specifically for Asian Indian population as specified in the revised guidelines for diagnosis of obesity in Asian Indians⁹ (i.e., $BMI \geq 25 \text{ kg/m}^2$) participated in the trial. With an alpha = 0.05, Cohen's $d=0.53$ (determined from change in BMI at nine month follow up in the YG), the power was 1.000 calculated using G power software.¹⁰ Participants were recruited with flyers in hospitals around the research center. Participation in the study was entirely voluntary. Participants were included if they had: (i) $BMI \geq 25 \text{ kg/m}^2$ and (ii) were between 20 and 59 years of age. Participants were excluded if they had (i) obesity secondary to hormonal imbalance, medication such as steroids or secondary to any other medical condition, (ii) any physical or psychological disability which would have prevented the participants from taking part in the yoga program or attending the nutritional advice session, (iii) involvement in any other dietary or exercise program during the 12 months prior to, at the time of or during the study, and (iv) any uncontrolled co-morbid condition associated with obesity such as cardiovascular disease, type-2 diabetes mellitus, or hypertension. No participant was excluded from the trial for the above mentioned reasons. The participants' written signed informed consent was taken. The baseline characteristics of the participants are presented in Table 1.

Study design

CONSORT guidelines for reporting were followed. The study was carried out between April 2016 and July 2017. In the present single blind, comparative controlled trial the participants belonged to two groups (*viz.*

yoga group (YG) and nutritional advice group (NAG)). Participants were prospectively recruited in fifteen centers across India and informed that they could be assigned to either YG or NAG. A researcher assigned participants either to YG or NAG based on convenience of scheduling assessments and sessions in the fifteen centers. Participants were not allowed to choose their intervention.

The participants in the YG received a practical yoga session for 75 minutes/day for three consecutive days in a week during the nine months of the trial. Also, the participants were given a diet plan for 1,900–2,000 Kcal/day which was developed based on the guidance from the National Institute of Nutrition, Hyderabad, India.¹¹ The participants in the NAG were given lectures on nutrition (one 45 minute lecture/week) along with the same diet plan for 1900-2000 Kcal/day as of the YG. Adherence to yoga or nutritional advice was based on the instructor's notes in the class. The participants of both groups were assessed for physical activity levels at baseline, and during the follow-up period of 9 months, using the International Physical Activity Questionnaire-Short Form.¹² The study was approved by the institution's ethics committee (Approval number: YRD/016/022). The trial is registered with the Clinical Trials Registry of India (CTRI/2018/05/014077).

Assessments

The following assessments were made by individuals who were blinded to the groups the participants belonged to.

Anthropometry and related indices

The participants were assessed in light clothing and without footwear for the following anthropometry variables following standard procedure:⁶ (i) BMI, (ii) waist circumference (WC), (iii) hip circumference

(HC) and (iv) sagittal abdominal diameter (SAD).^{6, 13}

The following anthropometry indices were calculated using the standard formulae: (i) waist-hip ratio (WHR), (ii) a body shape index (ABSI),¹⁴ (iii) Conicity index (CI),¹⁴ (iv) Abdominal volume index (AVI),¹⁴ (v) Visceral adiposity index (VAI),¹⁵ (vi) Body roundness index (BRI).¹⁴

Biochemical measures

Antecubital venous blood samples were collected from each participant. Estimation of fasting blood glucose, total cholesterol, triglycerides, high density, and low density lipoprotein cholesterol were carried out using appropriate enzymes followed by spectrophotometry.

Energy intake (Kcal/day)

Energy intake/day was estimated by a structured interview of the participants during which they were asked to recall (i) the foods and fluids consumed in the 24 h prior to the assessment, (ii) the method used in preparing the foods and fluids (e.g., raw, cooked, boiled, or baked), and (iii) the size of utensils in which the foods and fluids were consumed based on standard reported sizes.¹⁶ The total energy intake/day and macronutrients were estimated according to norms for Indian foods.^{11, 16, 17}

Energy expenditure/day

Energy expenditure/day was estimated from (i) the levels of physical activity (derived from data of the International Physical Activity Questionnaire Short Form (IPAQ))¹² and (ii) basal metabolic rate of each participant (calculated using the Harris-Benedict equation).

Quality of life (QoL)

The Moorehead-Ardelt Quality of Life Questionnaire was used to determine the six dimensions of the QoL (i.e., general self-esteem, physical wellbeing, social contacts, satisfaction concerning work, pleasure related to sexuality, and focus on eating

behaviour), with scores ranging from -0.5 to +0.5. The sum of scores of these 6 dimensions provided a total QoL score.

Intervention

Nutritional advice: A 45 min talk on nutrition (1 /week) was presented for 9 months by a person with over 12 years of education, including 2 years of training in science. The presentations were delivered in an easily accessible center, which participants were encouraged to attend with follow-up reminders each week for the 9 months. There were 24 topics for the presentations (supplementary Table). The first 12 topics were repeated after 24 weeks and each presentation was followed by an interactive session.

Yoga: The yoga program consisted of (i) a secular prayer (3 min), (ii) yoga postures (*asanas*, 42 min), (iii) volitional breathing (*pranayamas*, 24 min), and (iv) guided relaxation with meditation (6 min). Yoga sessions were conducted on three successive days in a week between (i) 05:30 h and 06:45 h, during the study period. Attendance was noted in each yoga class by the yoga teacher. All the participants in the yoga group attended at least 50 percent of the total yoga classes. The yoga teacher was also asked to note any adverse event during the classes. The yoga teacher had a minimum of five years of experience teaching yoga. Details of the yoga intervention are given in Table 2.

Data analyses

Data were analysed using SPSS version 24.

(i) χ^2 test was carried out to determine the differences in the percentages of participants in the two groups who achieved weight loss of five percent or more at three, six and nine months. Cramer's V was calculated to determine the strength of the association between the variables studied. Cramer's V > 0.10 was considered as the critical value to report a moderate association between the

variables studied based on categorization of Cramer's V elsewhere.¹⁸

(ii) Also, linear mixed model analyses with intention to treat analyses were used to examine the effect of yoga or nutritional advice on outcome variables. Separate models were developed for each of the outcome variables. In each model, the fixed factors were Time points (four time points for assessment of the outcome variables; 4 levels) and Groups (yoga and nutritional advice groups, two levels); age (continuous variable) and gender (categorical variable) as covariates; and participants as a random factor. The level of significance was set at $\alpha = 0.05$ (two-tailed). Bonferroni corrected *post hoc* tests were conducted for models with a significant main effect of Time X Groups, Time and Groups.

Results

The number of participants at different stages of the trial is presented in Figure 1. No adverse outcomes were reported in either group.

Chi square analyses

The percentages of the participants who achieved weight loss of five percent or more was significantly higher in YG compared to NAG in three months (22.81 percent in the YG versus 7.29 percent in the NAG; $\chi^2 = 26.3638$, Cramer's V = 0.17, $p < 0.001$), six months (26.38 percent in the YG versus 12.80 percent in the NAG; $\chi^2 = 11.94$, Cramer's V = 0.12, $p = 0.004$) and in the nine months (23.7 percent in the YG versus 7.2 percent in the NAG; $\chi^2 = 16.01$, Cramer's V = 0.15, $p < 0.01$). The number of participants who achieved weight loss of five percent or more is presented in Table 3.

Linear mixed model analyses

There was a significant interaction effect of Groups and Time for (i) BMI ($F_{3,801.976} = 5.888$, $p = 0.001$), (ii) WC ($F_{3,794.026} = 4.246$, $p = 0.005$), (iii) SAD ($F_{3,786.596} = 10.784$, $p < 0.001$), (iv) AVI

($F_{3,794.592}=4.817$, $p=0.002$), (v) BRI ($F_{3,792.726}=3.813$, $p=0.010$), (vi) Fasting blood glucose ($F_{3,453}=3.449$, $p=0.017$) and (vi) self reported ability to work (a dimension of the quality of life) ($F_{3,654.528}=2.667$, $p=0.047$).

A significant main effect of Time was observed for (i) BMI ($F_{3,801.976}=38.775$, $p<0.001$), (ii) WC ($F_{3,794.026}=50.865$, $p<0.001$), (iii) SAD ($F_{3,786.596}=19.575$, $p<0.001$), (iv) HC ($F_{3,799.797}=13.826$, $p<0.001$), (v) ABSI ($F_{3,798.272}=14.371$, $p<0.001$), (vi) CI ($F_{3,800.817}=22.596$, $p<0.001$), (vii) AVI ($F_{3,794.592}=48.343$, $p<0.001$), (viii) BRI ($F_{3,792.726}=51.629$, $p<0.001$), (ix) VAI ($F_{3,536.107}=7.478$, $p<0.001$), (x) total cholesterol ($F_{3,657.186}=7.557$, $p<0.001$), (xi) LDL cholesterol ($F_{3,654.923}=7.616$, $p<0.001$), (xii) triglycerides ($F_{3,614.544}=4.300$, $p=0.005$), (xiii) HDL cholesterol ($F_{3,676.708}=5.539$, $p=0.001$), (xiv) general self-esteem ($F_{3,668.903}=7.031$, $p<0.001$), (xv) physical wellbeing ($F_{3,674.705}=3.161$, $p=0.024$), (xvi) social contacts ($F_{3,672.840}=3.086$, $p=0.027$), (xvii) satisfaction concerning work ($F_{3,654.528}=3.624$, $p=0.013$), (xviii) pleasure related to sexuality ($F_{3,588.516}=2.968$, $p=0.031$), and (xix) total quality of life ($F_{3,653.383}=7.292$, $p<0.001$).

A significant main effect of the Groups was observed for (i) BMI ($F_{1,306.775}=5.651$, $p=0.018$), and (ii) SAD ($F_{1,305.804}=37.376$, $p<0.001$).

Post hoc analyses

In the pair wise post-pre comparisons, YG decreased BMI, WC, SAD, HC, ABSI, CI, AVI and BRI at 3 months, 6 months and 9 months whereas VAI at 6 months and 9 months, triglycerides and fasting blood glucose at 9 months. The YG also increased total cholesterol at 6 months, LDL cholesterol at 3 months, and HDL cholesterol at 9 months ($p_{adj} < 0.05$; in all cases). Also, the YG increased general self

esteem, physical wellbeing and total quality of life at 3 months, 6 months and 9 months ($p_{adj} < 0.05$; in all cases) while social contacts at 9 months and satisfaction concerning work at 3 months and 6 months ($p_{adj} < 0.05$; in all cases).

In the pairwise comparisons, NAG decreased BMI and HC (at 3 and 6 month follow-ups), WC, AVI, and BRI (at 3, 6 and 9 month follow-ups), ABSI, CI, and VAI (at 6 and 9 month follow-ups) compared to baseline values. The NAG also increased total cholesterol at 6 months, LDL cholesterol at 3 months and total quality of life at 3 months ($p_{adj} < 0.05$; in all cases).

The estimated marginal mean \pm SD values for the variables studied at different time points are presented in Table 4. The group mean \pm SD values for estimated energy intake/day and energy expenditure/day are presented in Table 5.

Discussion

Two groups of obese persons receiving either yoga or nutritional advice were assessed at baseline and followed up following three, six and nine months of either yoga or nutritional advice. The percentage of persons with a weight loss exceeding five percent was significantly more in the YG versus the NAG at three, six months and nine months. These findings are supported by the significantly lower sagittal abdominal diameter (SAD) after three, six and nine months of yoga but not following nutritional advice. The waist circumference is considered an indicator of central obesity though not specifically of visceral adiposity,¹⁹ however the SAD is a valid and reliable measure of visceral adiposity irrespective of the body size of the individual.^{20, 21} The SAD measures abdominal height which closely reflects visceral adiposity, while the waist circumference which assesses both

abdominal height and width, hence making waist circumference a less accurate indicator of visceral adiposity than SAD in the obese.²² Since the SAD was significantly lower after yoga but not following NA, this suggests that a decrease in visceral adiposity occurred in the YG alone.

These findings are in line with the changes in certain indices which indicate increased risk of cardiovascular and metabolic disorders associated with central obesity.²³ Among these indices, ABSI and CI which specifically reflect distribution of adipose tissue centrally;^{24, 25} decreased in both groups at six and nine months but in the YG alone at three months, suggesting that there may be exclusive benefits of yoga related to earlier reduction of central adiposity and associated risks of disease. The AVI, correlated with impaired glucose tolerance and higher incidence of both type 2 diabetes mellitus and metabolic syndrome)²⁶ and the BRI (associated with higher occurrence of non-alcoholic fatty liver disease)²⁷ showed comparable decrease in both YG and NAG groups at all follow up assessments suggesting that the risk of associated conditions could be lower in both groups. The VAI which significantly correlated with all metabolic syndrome factors and with cardio- and cerebrovascular events reduced in both groups at six and nine months.^{28, 29} The comparable changes in AVI, BRI, and VAI can be correlated with comparable decreases in both groups in the waist circumference at the three points of follow up.

Both groups had mild hypertriglyceridaemia at baseline, with the corresponding risk of atherosclerotic cardiovascular disease, independent of other metabolic disorders.³⁰ The decrease in triglyceride levels in the YG at nine months is consistent with previous reports of decreased triglyceride levels following

yoga.³¹ The increase in HDL levels in the YG alone at nine months has the benefits of raised HDL levels including reduced risk for coronary heart disease development and of associated complications such as myocardial infarction or stroke;³² comparable to previous reports of the benefits of yoga practice in restoring lipid levels to normal in vulnerable populations.^{31, 33} Also, at nine months follow up in the YG alone, there was a significant decrease in fasting blood glucose levels, supporting the need for continued practice to see benefits at different levels. The increase in LDL in both groups at three months and in total cholesterol at six months is difficult to explain. These increases may be due to associated social and environmental factors in both groups since participants from both groups belonged to the same geographical region and had comparable social-cultural backgrounds. The three monthly assessments corresponded to July-August (the monsoon season) whereas the six monthly assessments corresponded to October-November (the start of winter and of seasonal holidays). Seasonal factors as well as holidays and festivities are known to contribute to changes in lipid levels, which may be the case in the present study.³⁴ Participants with three, six and nine months of yoga practice significantly improved their overall quality of life compared to their pre-yoga assessment, whereas the NAG improved their quality of life relative to the respective baseline at three months alone. Physical wellbeing, work satisfaction, social contacts and self-esteem were the dimensions of quality of life which improved in the YG at three, six and nine months, but did not change in the NAG at any follow up. Yoga practice specifically emphasizes body awareness and responsiveness leading to greater body satisfaction and lower levels of trait self-

objectification.³⁵ Hence yoga practice may improve self-esteem, as well physical functioning and social wellbeing leading to an improved total quality of life in the YG alone at six and nine months.^{35, 36} The improved total quality of life in the NAG group at three months could be related to weight loss and associated benefits at this follow up.

Participants of both groups had comparable levels of energy intake and energy expenditure at all assessments based on qualitative reports. Also, the energy derived from protein, carbohydrate and fat, was comparable in the two groups at all points of assessment during the nine month trial.

The findings of the present study are limited by the study design and intervention allocation method. An initial attempt to randomly assign participants to the two interventions was not successful due to experimental constraints. Also, the present study design includes differences in the ‘dose’ of the two interventions (i.e., three

Legend for Figure 1:

Trial profile.

sessions (each of 75 min) of yoga/week versus one session (of 45 min) of nutritional advice/week as well. Future research with randomization to yoga and active control interventions of comparable duration and frequency would overcome this difference.

Conclusions

The percentage of persons with a clinically relevant weight loss exceeding five percent was significantly more in the YG versus the NA at three, six and nine month follow-ups. After nine months of yoga alone, there was a decrease in the SAD, triglycerides and fasting blood glucose levels with an increase in HDL. The total cholesterol and LDL increased in both groups at 3 and 6 months respectively. The total quality of life increased in both groups at three months, however in the YG alone the total quality of life and sub-components of it (i.e., self-esteem, physical wellbeing, work satisfaction, social contacts) increased at six and nine months.

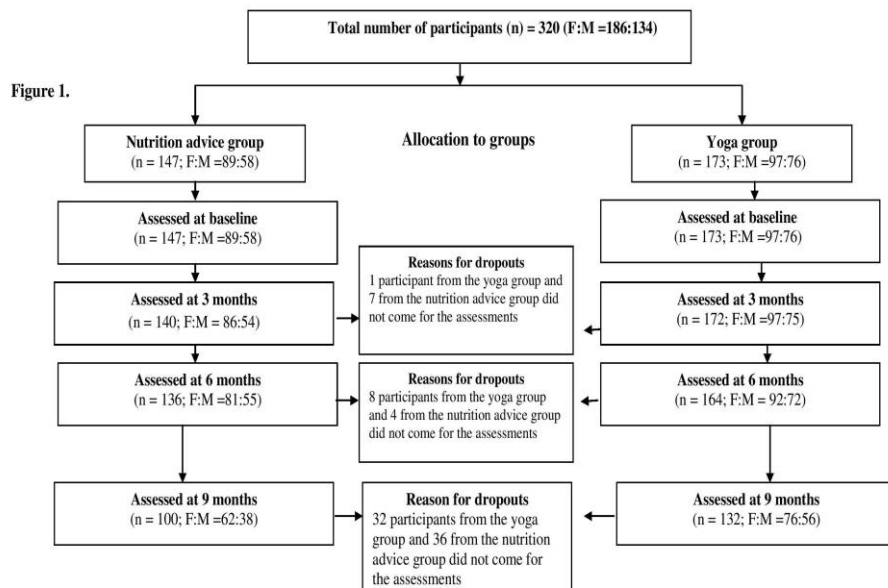


Table 1. Baseline characteristics of the participants

Characteristics	Yoga group	Nutritional advice group
Number of participants (n)	173	147
Number of male participants (n)	76	58
Number of female participants (n)	97	89
Age in years (mean±SD)	43.35±9.08	47.39±10.69
BMI (in Kg/m ²) (mean±SD)	32.89±4.47	31.12±4.24
Energy intake (Kcal/day) (mean±SD)	1864.44±808.56	1816.72±679.06
Energy expenditure (Kcal/day) (mean±SD)	2565.66±414.72	2496.28±431.79

Table 2. Details of the yoga intervention.

SI. no.	Type of the yoga practice	Name of the yoga practice	Duration of the practice
I	Secular prayer	Easy posture (<i>sukhasana</i>) + secular prayer	3 minutes
II	Voluntarily regulated yoga breathing techniques (<i>pranayama</i>)	1. Bellows yoga breathing (<i>bhastrika pranayama</i>)	3 minutes
		2. High frequency yoga breathing (<i>kapalabhati</i>)	6 minutes
		3. Victorious breathing (<i>ujjayi pranayama</i>)	3 minutes
		4. Alternate nostril yoga breathing (<i>anulom-vilom</i>)	6 minutes
		5. Bumblebee breathing (<i>bhramari</i>)	3 minutes
		6. OM chanting (<i>udgeeth</i>)	3 minutes
III	Standing postures (<i>asanas</i>)	1. Swaying palm tree pose (<i>tirryaktadasana</i>) (right side, left side with 10 repetitions; normal breathing and eyes closed)	3 minutes
		2. Triangle pose (<i>trikonasana</i>)	3 minutes
		3. Angle pose (<i>konasana</i>) (Right side, then left side; maintain the posture for at least 15 seconds on either side with eyes closed and normal breathing)	3 minutes
		4. Hand to foot pose (<i>padahastanasana</i>) (Holding the posture for at least 15 seconds with normal breathing and eyes closed)	1 minute
IV	Sitting postures	1. Mill churning pose (<i>chakkiasana</i>) Seated with legs extended, hands stretched out	3 minutes

	(<i>asanas</i>)	and fingers interlaced. Each movement would involve forward bending and making circles with the extended arms keeping the spine erect (15 rounds, clockwise; 15 rounds anti-clockwise with normal breathing and eyes closed)	
		2. Static angle pose (<i>sthitta konaasana</i>) Extending both legs and keeping them one forearm span apart while seated, then holding the left big toe with the right hand while the left arm is extended upward. The person should face the extended left arm keeping the spine erect. During the practice there should be normal breathing and eyes closed. The posture should be maintained for at least 15 seconds. The practice is repeated on the opposite side.	3 minutes
		3. Seated forward bend pose (<i>paschimottanasana</i>) (Holding the posture for at least 15 seconds with normal breathing and eyes closed)	1 minute
		1. Half plough pose (<i>ardhahalasana</i>) raising both legs to form a right angle, keeping the legs straight at the knee, repetitive (10 times with eyes closed and normal breathing)	3 minutes
	Supine postures	2. Cyclical leg pose (<i>padavrttasana</i>) raising the right leg extended at the knee and making circles in the air, rotating the leg (10 rounds clockwise and 10 rounds anticlockwise with normal breathing and eyes closed). The practice is repeated with the left leg with 10 rounds clockwise and 10 rounds anticlockwise.	6 minutes
V	(<i>asanas</i>)	3. Cycling pose (<i>dwicakriasana</i>) repetitive (10 times with eyes closed and normal breathing)	3 minutes
		4. Monkey pose (<i>markatasana</i>) this is a spinal twist (right side, left side with 10 repetitions; normal breathing and eyes closed)	6 minutes

		1. Cobra pose (<i>bhujangaasana</i>) Two methods are followed.	6 minutes
VI	Prone postures (<i>asanas</i>)	Method 1 - Lie prone with extended elbows and the palms near the chest, flat on the ground. Then the upper part of the body till the waist is raised while looking upwards and forwards. The weight of the upper parts of the body should be evenly distributed on both hands. The procedure is repeated 10 times with eyes closed and normal breathing. The second method is almost the same except that the hands are not kept apart but with the right palm over the left palm. The rest of the procedure is the same. This method is also repeated 10 times with normal breathing and eyes closed.	
		2. Locust pose (<i>salabhasana</i>) (remaining in the posture for at least 15 seconds with normal breathing and eyes closed)	1 minutes
VII	Guided relaxation	1. Corpse pose (<i>shavasana</i>) with breath awareness	6 minutes
Total duration			75 minutes

Table 3. The number of participants under different weight loss categories following yoga and nutritional advice

Weight loss categories	Yoga; n (%)	Nutritional advice; n (%)	Yoga; n (%)	Nutritional advice; n (%)	Yoga; n (%)	Nutritional advice; n (%)
	3 months*		6 months*		9 months*	
> 5% weight loss	39 (22.81)	10 (7.29)	43 (26.38)	17 (12.80)	31 (23.66)	7 (7.21)
3-5% weight loss	32 (18.71)	21 (15.32)	35 (21.47)	22 (16.50)	28 (21.37)	18 (18.56)
< 3% weight loss	83 (48.54)	67 (48.90)	47 (28.83)	49 (36.84)	45 (34.35)	34 (35.05)
No change in weight	17 (9.94)	39 (28.50)	38 (23.31)	45 (33.83)	27 (20.61)	38 (39.78)

* $p < 0.05$; χ^2 test for differences between the two groups.

Table 4. Changes in anthropometry variables, indices, biochemical measures and quality of life at 3 months, 6 months and 9 months of yoga or nutrition advice.

Variables	Yoga (n=173)				Nutritional advice (n=147)			
	BL	3M	6M	9M	BL	3M	6M	9M
BMI (Kg/m ²)	32.82±4.47	31.74±4.34*	31.68±4.44*	31.64±4.42*	31.21±4.24#	30.48±4.35*#	30.67±4.25*#	30.85±4.40
Waist circumference (cm)	107.04±10.66	102.79±10.63*	101.65±10.76*	101.44±11.08*	103.62±8.79	101.18±8.69*	99.96±8.66*	101.08±10.80*
SAD (cm)	25.42±2.74	24.51±2.69*	24.33±2.84*	24.25±3.13*	22.03±5.26#	21.76±5.10#	21.80±4.83#	21.98±4.50#
Hip circumference (cm)	110.80±10.89	107.64±12.00*	107.73±9.42*	106.99±11.19*	108.33±9.23	105.83±12.53*	105.93±9.24*	106.45±9.04
Waist/hip ratio	0.98±0.24	1.00±0.64	0.94±0.08	0.95±0.07	0.96±0.07	1.02±0.79	0.95±0.08	0.95±0.08
A body shape index	0.08±0.01	0.08±0.01*	0.08±0.01*	0.08±0.01*	0.08±0.01	0.08±0.01	0.08±0.01*	0.08±0.01*
Conicity index	1.35±0.09	1.32±0.09*	1.31±0.09*	1.32±0.11*	1.35±0.07	1.34±0.10	1.31±0.08*	1.32±0.10*
Abdominal volume index	23.35±4.62	21.59±4.50*	20.98±4.47*	21.14±4.36*	21.61±3.65	20.68±3.72*	20.13±3.48*	21.20±4.82*
Visceral adiposity index	3.16±1.92	2.95±2.11	2.48±1.29*	2.52±1.48*	2.85±2.24	2.71±1.53	2.40±1.08*	2.42±1.07*
Body roundness index	7.11±1.83	6.42±1.83*	6.09±2.03*	5.21±3.15*	6.65±1.50	6.23±1.44*	6.10±1.44*	6.53±1.72*
Total cholesterol (mg/dL)	176.11±36.02	180.37±36.81	187.75±36.04*	181.52±38.28	174.22±34.09	188.32±37.60	186.53±39.18*	182.70±42.69
Triglycerides (mg/dL)	169.66±91.61	158.54±92.73	154.28±85.59	151.19±83.16*	157.59±84.93	155.46±79.76	145.46±67.13	146.88±65.08
LDL cholesterol (mg/dL)	109.13±39.05	122.48±33.63*	123.78±29.81	120.00±35.84	114.54±30.77	127.37±34.10*	121.04±31.13	120.59±34.38
HDL cholesterol (mg/dL)	43.65±13.57	42.54±10.25	45.98±10.94	46.95±11.41*	46.27±11.94	46.38±11.50	48.17±12.64	47.45±10.43
VLDL (mg/dL)	33.93±18.32	31.02±16.52	30.35±16.26	29.61±15.05	30.24±13.32	30.42±14.42	29.09±13.43	28.77±11.68
Fasting blood glucose (mg/dL)	103.5±19.8	101.6±20.1	101.1±15.6	96.9±11.01*	99.9±15.0	101.1±15.3	100.2±17.6	101.8±15.1
General self-esteem	0.21±0.21	0.25±0.19*	0.28±0.18*	0.29±0.15*	0.23±0.22	0.26±0.18	0.25±0.18	0.27±0.18
Physical activity	0.20±0.25	0.27±0.17*	0.26±0.20*	0.26±0.19*	0.23±0.24	0.24±0.20	0.22±0.22	0.23±0.24
Social contacts	0.25±0.22	0.27±0.17	0.28±0.18	0.30±0.17*	0.23±0.23	0.27±0.22	0.26±0.21	0.26±0.20
Satisfaction concerning work	0.24±0.23	0.30±0.17*	0.30±0.17*	0.30±0.17	0.29±0.21	0.31±0.18	0.29±0.18	0.27±0.23
Pleasure related to sexuality	0.15±0.29	0.16±0.28	0.18±0.24	0.12±0.27	0.03±0.31	0.05±0.32	0.08±0.29	0.01±0.31
Focus on eating behavior	0.19±0.25	0.25±0.21	0.24±0.20	0.22±0.22	0.21±0.23	0.25±0.22	0.26±0.22	0.22±0.22
Total quality of life	1.22±1.01	1.48±0.83*	1.54±0.85*	1.48±0.76*	1.21±0.92	1.39±0.91*	1.35±0.86	1.25±1.07

* $p_{adj} < 0.05$; Bonferroni adjusted pairwise comparisons, values compared with baseline values in a group.

$p_{adj} < 0.05$; Bonferroni adjusted pairwise comparisons, values of a group compared with respective time point value of the other group

Table 5. Estimated ratio of macronutrients/day, total energy intake/day and energy expenditure/day at baseline, 3 months, 6 months and 9 months in the yoga and nutritional advice groups.

Variables	Yoga				Nutritional advice			
	BL	3M	6M	9M	BL	3M	6M	9M
Protein (gm/day)	68.1±36.29	61.88±51.27	64.30±39.44	70.80±57.25	69.25±33.77	61.30±40.12	63.50±26.54	62.38±32.34
Fat (gm/day)	46.26±28.15	48.12±33.65	48.04±31.77	56.46±39.33	49.10±30.37	50.14±30.63	50.06±26.32	52.44±32.25
Carbohydrates (gm/day)	250.03±119.19	215.73±110.35	216.76±97.99	234.52±123.58	227.54±97.26	202.75±82.69	212.09±74.92	188.85±78.96
Energy intake/day (Kcal/day)	1864.44±808.56	1733.10±1002.49	1749.65±846.52	1809.47±926.63	1816.72±679.06	1651.14±762.01	1758.81±599.68	1664.92±757.16
Energy expenditure/day (Kcal/day)	2565.66±414.72	2507.21±434.31	2515.64±424.45	2484.87±430.50	2496.28±431.79	2485.64±471.16	2487.83±412.11	2434.19±547.82

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