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Short term health impact of a yoga and diet change program on obesity

Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Data Interpretation
- E** Manuscript Preparation
- F** Literature Search
- G** Funds Collection

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Background:

Obese persons often find physical activity difficult. The effects of a yoga and diet change program, emphasizing breathing techniques practiced while seated, was assessed in obese persons.

Material/Methods:

A single group of 47 persons were assessed on the first and last day of a yoga and diet change program, with 6 days of the intervention between assessments. The assessments were: body mass index (BMI), waist and hip circumferences, mid-arm circumference, body composition, hand grip strength, postural stability, serum lipid profile and fasting serum leptin levels. Participants practiced yoga for 5 hours every day and had a low fat, high fiber, vegetarian diet. Last and first day data were compared using a t-test for paired data.

Results:

Following the 6-day residential program, participants showed a decrease in BMI (1.6 percent), waist and hip circumferences, fat-free mass, total cholesterol (7.7 percent decrease), high density lipoprotein (HDL) cholesterol (8.7 percent decrease), fasting serum leptin levels (44.2 percent decrease) and an increase in postural stability and hand grip strength ($p < 0.05$, all comparisons).

Conclusions:

A 6-day yoga and diet change program decreased the BMI and the fat-free mass. Total cholesterol also decreased due to reduced HDL levels. This suggests that a brief, intensive yoga program with a change in diet can pose certain risks. Benefits seen were better postural stability, grip strength (though a 'practice effect' was not ruled out), reduced waist and hip circumferences and a decrease in serum leptin levels.

key words:

obesity • body mass index • postural stability • leptin • yoga

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BACKGROUND

Overeating energy-dense, nutrient-poor foods and a sedentary lifestyle have led to an epidemic of obesity and type 2 diabetes all over the world [1]. It has been recognized that Asian and Latin American populations are especially prone to develop abdominal obesity, type 2 diabetes, and hypertension [2]. Another vulnerable group is African-Americans, who constitute one of the largest ethnic groups in the United States [3]. Health disparities among African-American populations include a greater risk of heart disease, hypertension, and type 2 diabetes, as well as other conditions. Increasingly, it is considered that the best way to bring about a lasting change in people who are overweight is through lifestyle modification [4].

For many physically inactive people who are overweight, any kind of physical activity appears difficult, and this often prevents people who are obese from initiating and adhering to a specific form of physical activity [5]. The ancient Indian science of yoga is a way of life which includes changes in mental attitude, diet, and the practice of specific techniques such as yoga postures (*asanas*), breathing practices (*pranayamas*), and meditation [6]. Among different yoga techniques, breathing practices (*pranayamas*) can be performed while seated, and are less challenging for people who are physically inactive [7]. A combination of yoga practices which emphasized breathing techniques was shown to reduce the body mass index (BMI) in 177 obese persons after 7 days of a yoga intervention [8].

Apart from yoga, a low-fat, low-energy, lacto-ovo-vegetarian diet combined with physical activity, and a stress-free environment have been shown to have a positive impact on risk factors for cardiovascular diseases, including the effect on BMI and total cholesterol [9].

Being overweight has several undesirable effects. For example, obese persons have been shown to have poor musculoskeletal fitness (based on push-ups, sit-ups, grip strength, and trunk flexibility), and this is of importance, as over a 20-year period musculoskeletal fitness is a significant predictor of weight gain [10]. Also, in people who are overweight, mobility is compromised, which is closely related to decreases in proprioception [11] and balance stability [12]. Postural instability in extremely obese persons has been shown to improve after a 3-week body weight reduction program [13].

Until now there has been no study which has examined the short term impact of a yoga program which included a change in diet in obese persons on variables others than the BMI and lipid profile. Hence the present study was aimed at assessing the impact of a 6-day yoga program on the BMI, anthropometric measures, postural stability, hand grip strength, serum lipid profile and fasting serum leptin levels in obese persons.

MATERIAL AND METHODS

Participants

Forty-seven participants who had a body mass index (BMI) more than 30 kg/m² were selected from 64 overweight persons (BMI >25 kg/m²) who had enrolled in a 1-week yoga camp. Their ages ranged between 17 and 68 years (group

average \pm S.D., 40.3 \pm 10.2 years; 16 males). The camp participants were all Indian, most were from northern India, and their diets were similar. Based on their income and educational level they could be categorized as belonging to a middle-income group, and most had their own businesses, with the level of education of most of them being up to the level of graduation. None of them had done yoga before.

The selection criteria included: (1) BMI (>30 kg/m²), (2) absence of a disease which could have contributed to obesity (e.g., hypothyroidism, polycystic ovarian syndrome), or (3) conditions which required treatment which could have resulted in weight gain (e.g., conditions which required treatment with steroids). Participants who had other diseases which were disabling or were not controlled with medication were also excluded. Seven persons with hypertension were not excluded as they had mild hypertension, without any systemic complications and their blood pressure was controlled by medication.

The 64 overweight persons belonged to a larger sample of 340 persons who were enrolled in the camp for the management of different illnesses and had responded to advertisements on television. The study design was explained to them and they gave their signed consent to participate. The participants paid to participate in the camp and did not receive any payment for taking part in the trial. The study was approved by the ethics committee of the institution, Patanjali Yogpeeth, located in Haridwar, north India.

Design and setting

The trial was a single group, longitudinal trial. Participants were assessed on day 1 and day 6 of the 6-day residential yoga camp. The yoga camp was held in a residential yoga therapy centre in northern India.

Assessments

Body Mass Index

The body mass index (BMI) was calculated as the body weight (in kg), in light clothing and without shoes, divided by height (in m) squared. Body weight was measured to 0.05 kg using an electronic balance (GTEP Precision Electronic Instruments Model No.11, New Delhi, India). Height was measured to the nearest 0.1 cm (Gulick Anthropometric tape, model J00305, Lafayette Instrument, U.S.A.).

Waist circumference

Waist circumference is considered a reliable measure in clinical practice [14]. Participants were lightly clothed and asked to stand upright with feet 25 to 30 cm apart and weight evenly distributed. The tape which was used for measurements (Gulick Anthropometric tape Model J00305, Lafayette Instrument, U.S.A.) was fitted around the abdominal girth without compressing soft tissue. The waist circumference was measured to the nearest 0.1 cm in a horizontal plane midway between the inferior costal margin and the iliac crest.

Hip circumference

Hip circumference was measured around the pelvis at the point of maximal protrusion of the buttocks. The ratio of

the waist circumference to the hip circumference was derived and is a ratio between the fat stored centrally inside the abdomen (waist circumference) and fat stored peripherally (hip circumference).

Mid-arm circumference

The mid-arm circumference was measured as the circumference of the non-dominant arm mid-way between the bony prominence of the shoulder (the acromion) and the elbow (the olecranon). This circumference includes muscle mass and a circumferential skin fold.

Body composition

Body composition was determined by a body composition analyzer (BF-907, Maltron, U.K.). Assessments were recorded with a minimum 2-hour gap between the previous meal and the recording. Also, none of the participants had excessive sweating or consumed excess fluid prior to recording. A standard method was used for recording, with participants resting supine, with their legs and arms slightly apart [15]. All relevant parameters were entered in the recording unit.

Four electrodes were applied on the right side of the body, on the hand, wrist, foot, and ankle. The total duration for recording was 5 minutes.

Postural stability

Postural stability was measured using a stability platform (Lafayette Instrument, model 16030, U.S.A.). The platform position was horizontal, with tension at medium. Participants mounted the platform supported by the hand rail, and stood with their feet approximately 25 cm. apart, their eyes open, and without support. It is known that in platform measurements the most frequently used duration is between 20 and 30 seconds, though longer [16] and shorter [17] measuring times have also been used. In the present test there were 3 'test' times of 20, 40, and 60 seconds with a 20-second 'rest' time in between. When a test was in progress the time spent tilted towards the left, the right, or at the centre was displayed on the screen. As each test cycle ended, the data were updated, and at the completion of the test the times and counts for a single trial were displayed, the count value being the number of times the platform was tilted to the left, right, or the centre during the test. For each participant there were 3 test cycles.

Hand grip strength

Participants were asked to stand and keep their arms raised pointing sideways, with the elbow extended, and parallel to the ground. In this position the hand grip strength (in kg) was assessed using a mechanical hand grip dynamometer (Lafayette Instrument, model 7498-05, U.S.A.). Each hand was tested in 3 trials given alternately, spaced 10 seconds apart. All participants were right hand dominant based on their response to a standard handedness inventory. For each hand the best value obtained in the 3 trials was used for analysis.

Biochemical measurements

Blood samples were collected using a tourniquet after an overnight fast. Total cholesterol, triglycerides, high density

and low density lipoprotein cholesterol were estimated by spectrophotometry. Fasting serum leptin levels were estimated by radioimmunoassay.

Intervention

The yoga camp had 2 components: a yoga program, and a diet which can be described as being based on yoga texts [18]. The yoga program consisted of 2 sessions each day. The first session was between 05:00 hours and 07:30 hours and the second session was between 17:00 hours and 19:30 hours. In a day participants practiced voluntarily regulated yoga breathing (*kriyas* or cleansing techniques and *pranayamas*). The program also included loosening exercises (*sukshma vyayamas*), and yoga postures (*asanas*). In this yoga program the emphasis was on yoga breathing techniques. The breathing techniques included high frequency yoga breathing (*kapalabhati*), breathing through alternate nostrils (*anulom-vilom pranayama*), exhalation with specific sounds (*brahmari* and *udgeeth pranayamas*), and breathing with a period of breath holding (*bahya*), or with a voluntarily partially constricted glottis (*ujjayi pranayamas*).

Participants were given a diet with fresh fruits and vegetables, lentils, cow-milk and complex carbohydrates. All participants had 3 meals a day at 07.30 hours, 13.00 hours, and 19.45 hours. There was no attempt to limit or restrict the portion size, hence this cannot be considered a calorie restricted diet. We also had no account of all participants' food intake. However, retrospectively we were able to get an account of 8 participants' diet during the camp and their calorie consumption was approximately 1965 Kcal/day, with 64 percent carbohydrates, 19 percent protein, 11 percent fiber, and 6 percent fat. These 8 participants cannot be considered representative of the entire group; nonetheless their calorie consumption may be indicative of the fact that participants did restrict their calorie intake even though they were not specially instructed to do so. The calorie content and composition of the diet were calculated using specific software designed to evaluate the calorie content and dietary composition of Indian foods (*Annapurna* 2000, Version 1.0, *Annapurna Associates*, Bangalore, India).

Data analysis

The data taken on the last day and on the first day of the residential yoga camp were compared with a t-test for paired data using SPSS version 16.0.

RESULTS

Following 6 days of yoga and a vegetarian diet, there was a significant decrease in BMI, lean mass, water content, waist circumference, hip circumference, total cholesterol, high density lipoprotein (HDL), and serum leptin levels ($p < 0.05$, comparing the values at the end of the camp with the values at the beginning; t-test for paired data). In contrast, there was a significant increase in bilateral hand grip strength and postural stability at 20, 40, and 60 seconds ($p < 0.05$, comparing the values at the end of the camp with the values at the beginning; t-test for paired data).

The groups mean values \pm S.D. are given in Table 1.

Table 1. Variables recorded at the beginning (Initial) and end (Final) of the yoga program are provided. Values are group mean \pm S.D.

Variables	Initial	Final
1. Body Mass Index (BMI)	35.97 \pm 5.72	35.40 \pm 6.09**
2. Fat (kg)	37.22 \pm 9.21	37.84 \pm 9.94
3. Lean (kg)	59.76 \pm 13.45	57.11 \pm 13.55***
4. Water (Lt)	43.74 \pm 9.84	41.81 \pm 9.91***
5. Waist circumference (cm)	44.16 \pm 5.07	42.44 \pm 6.31**
6. Hip circumference (cm)	48.67 \pm 5.28	46.98 \pm 5.42**
7. Waist/Hip ratio (cm)	0.91 \pm 0.09	0.91 \pm 0.10
8. Hand grip strength (R) (kg)	31.97 \pm 10.19	34.06 \pm 10.87***
9. Hand grip strength (L) (kg)	29.06 \pm 9.12	31.06 \pm 9.62**
10. Postural stability at 20 sec (sec)	8.78 \pm 9.04	19.81 \pm 0.50***
11. Postural stability at 40 sec (sec)	14.52 \pm 17.28	38.93 \pm 2.08***
12. Postural stability at 60 sec (sec)	23.60 \pm 27.09	57.51 \pm 10.55***
13. Cholesterol (mg/dl)	177.90 \pm 43.92	164.17 \pm 39.34
14. Triglycerides (mg/dl)	165.07 \pm 70.55	143.76 \pm 61.95
15. LDL (mg/dl)	107.77 \pm 32.24	108.10 \pm 32.36
16. HDL (mg/dl)	37.33 \pm 4.74	34.45 \pm 4.72**
17. Leptin (ng/ml)	53.71 \pm 34.61	29.95 \pm 21.57**

** $p < 0.01$, *** $p < 0.001$, Final values compared with Initial values, t-test for paired data, two tailed.

DISCUSSION

In the present single group study a 6-day residential yoga and vegetarian diet program reduced the body mass index (BMI), waist and hip circumferences, mid-arm circumference, the total cholesterol, high density lipoprotein (HDL) and serum leptin values, while the bilateral hand grip strength and the postural stability increased in 47 obese persons. Body composition analysis showed a decrease in the fat-free mass, i.e., the lean weight and water content.

The same yoga program assessed in the present study was tried earlier in 177 persons who were obese (i.e., with a BMI > 30 kg/m²) and in whom the BMI and lipid profile alone were assessed [8]. The yoga program was not residential, but the practices and duration of yoga practice was the same. In the non-residential camp participants were given advice about their diet, but there was no attempt to change their diet. The decrease in BMI in both studies was comparable (i.e., 0.57 kg/m² in the present study and 0.62 kg/m² reported earlier). In both studies there was also a decrease in total cholesterol.

In the present study the practice of yoga, as well as the low-fat, plant-based diet, may have accounted for the decrease in BMI. Adoption of a low fat, vegan diet for a longer period (14 weeks) was associated with significant weight loss in overweight postmenopausal women, despite the absence

of prescribed limits on portion size or energy intake [19]. Also, a 1-week program which used low-fat, low-energy, lacto-ovo-vegetarian diet and exercise, in a stress-free environment reduced body weight, BMI, serum cholesterol, and other risk factors for cardiovascular disease in 1349 volunteers studied [9]. In the present study, however, the decrease in BMI was accompanied by a decrease in lean muscle mass and water content based on body composition analysis, which was seen in participants of both sexes. An ideal structural physical training program should result in beneficial changes in body composition, with body fat reduction and an increase in muscle mass [20]. The decrease in lean muscle mass in the participants in the present study may have been related to the decrease in their energy intake, as calorie restriction has been shown to enhance a catabolic response leading to a decrease in lean muscle mass [21], though this was in combination with a period of inactivity which was not true of the present study, where participants remained active during the period of the study. It is not likely that the vegetarian diet was the basis for the change, as a study which compared the body composition in vegetarians and omnivorous persons did not report negative alterations in body composition in vegetarians [22]. It is also unlikely that the decrease in lean muscle mass was related to the practice of yoga, as in another study on diabetics yoga practice decreased body fat percentage and increased lean body mass [23]. The exact reason why the lean mass decreased remains to be understood. The decrease in water content could be associated with increased physical activity. This decrease would also have contributed to the decrease in BMI. While the reasons underlying the change are not clear, what is definite is that the decrease in BMI following the 6-day yoga and diet change program was due to a decrease in fat-free mass and hence could not be considered beneficial in these obese persons.

There was also a significant decrease in the waist circumference and in the hip circumference. However, there was no change in waist/hip circumference ratio, suggesting that there was no change in the ratio between fat stored centrally inside the abdomen (waist circumference) and fat stored peripherally (hip circumference).

The decrease in mid-arm circumference could be due to a decrease in the mid-arm muscle or in the circumferential skin fold layer, as the mid-arm muscle circumference was not calculated separately.

The obese participants in the present trial showed an increase in the time they were able to remain posturally stable or balanced after the yoga program. It has already been shown that in normal individuals [24] and in older persons [25] the practice of yoga improved the ability to balance. It is well recognized that a decrease in balance stability is strongly correlated with an increase in body weight, and is an important risk factor for falls in obese persons [12]; hence, the increase in balance following yoga would probably facilitate mobility in obese persons. This is essential for further participation and compliance with the yoga program or any physical activity program.

The participants also showed an increase in bilateral hand grip strength. In previous studies, yoga practice has been shown to increase hand grip strength in normal persons

[26] and in patients with rheumatoid arthritis [27]. The importance of an increase in hand grip strength in obese persons is that the hand grip strength is one of the indicators of musculoskeletal fitness, which is considered a significant predictor of weight gain [10]. While grip strength is a long term predictor of weight gain and mortality, the simultaneous increase in hand grip strength along with the decrease in lean muscle mass needs to be investigated, though it is known that the relation between grip strength and body composition has not been determined [28]. It may also be speculated that the increase in grip strength was due to a practice effect, or related to the fact that postural stability was better so that there was better fixation of the arms.

An earlier study has shown that the same yoga program as that of the present study reduced total cholesterol [8]; however the decrease in high-density lipoprotein seen in the present study, but not in the earlier one, may be related to the change in diet. In a study conducted on the effects of changing a Spanish-Mediterranean diet, eliminating all animal products (except eggs and milk) over a 2-month period, there was a decrease in total plasma cholesterol, as well as a decrease in high-density lipoprotein (HDL) levels [22]. In the present study the decrease in HDL levels may more likely be due to a change in diet (with a decrease in saturated and monounsaturated fat, and animal-source protein) rather than related to the practice of yoga. In fact studies conducted elsewhere have shown that yoga increases high density lipoprotein (HDL) levels [29,30]. The reason why HDL levels decreased in the present study could be related to the dietary change, and a study on the impact of the yoga program alone on HDL levels would be required to get this information. In any case, the decrease in HDL levels is not a favourable outcome, and, along with the decrease in fat-free mass, suggests that the 6-day program resulted in certain changes which were not beneficial. These may have been related to the drastic change in diet and to the fact that participants appeared to restrict their calorie intake even though there was no attempt to restrict portions.

Finally, the participants in the 6-day trial showed a decrease in fasting plasma leptin levels. This suggests that the program may have facilitated weight reduction, as a low leptin level for a given fat mass has been shown to be associated with a greater weight loss [31]. This is of importance, as the majority of obese human subjects have high plasma leptin levels that are related to the size of their adipose tissue mass [32]. Possibly defects in the leptin signaling cascade may play a role in the development of human obesity. The decrease in leptin levels following yoga may suggest that the program facilitated a state of energy balance. The mechanisms underlying these and other effects observed were not studied and remain unclear.

The main limitation of the present study is the fact that there was no non-intervention, control group. This is one of the difficulties encountered in a study of this kind where the participants have elected to join for a particular program and any other design (e.g., randomizing participants as intervention and wait-list control groups) would not be feasible. Participants who also join for a specific course would not have the time to participate in a trial as a 'wait-list' group. Also, a group who have chosen to enroll in a yoga program can be assumed to be particularly motivated

to practice yoga. A randomized controlled trial conducted on obese persons who do not self-select a yoga program for weight loss would be required to understand whether the findings can be generalized to most obese persons. Another limitation of the study is that the short-term impact of yoga was studied. The long term effect of the program, or even whether persons continued to practice yoga after returning home, needs to be evaluated. This is of interest as regular yoga practice for 4 or more years has been shown to be associated with attenuated weight gain based on multiple regression analyses to examine the association between yoga practice and weight maintenance in 15,550 adults aged between 53 and 57 years recruited as part of the Vitamin and Lifestyle (VITAL) cohort study between 2000 and 2002 [33].

The present trial can be considered preliminary, requiring a further randomized controlled trial and a follow-up to determine the long term impact of yoga and diet change on obesity. The trial has also raised concerns about the advisability of an intensive yoga program combined with a radical diet change in view of the body composition changes and the decrease in HDL levels. These results suggest that studying the effects of a more gradual change in change in diet, along with, or independent of, a yoga program, would be useful.

CONCLUSIONS

A 6-day residential yoga and diet change camp which included 5 hours of yoga practice and a high fiber vegetarian diet had the following effects in 47 obese persons: a decrease in the BMI, total cholesterol, high density lipoprotein (HDL), fasting serum leptin levels, waist and hip circumferences, lean mass and the body water content; while postural stability and bilateral hand grip strength increased. A decrease in fasting serum leptin levels was suggestive of an improvement in energy balance. However, the decreases in lean mass, water content, and HDL levels were not suggestive of improvement and were cause for concern. The long term impact of the intervention remains to be studied.

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