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Exploring the physiological effects of integrated intervention of yoga and diet counseling

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Abstract
Various researchers reported that both yoga and diet counseling have individually shown benefits in health as well as sickness. These two interventions improved domains of physiological parameters. However, there are very few studies evaluating the additive effect of these two interventions. Therefore, present study was designed to observe the effect of an integrated intervention package including yoga training and diet counseling on health status of young college-going females. The study compared the effects of 3 months of yoga training and diet counseling on physiological parameters e.g. (i) anthropometric variables like body weight, height, Body Mass Index, waist circumference, hip circumference and waist hip ratio (ii) cardio-respiratory variables like systolic and diastolic Blood Pressure (BP), pulse rate and oxygen saturation (iii) pain perception variables like pain threshold and pain tolerance in 60 young college-going females. All differences were pre-post intervention within the group. Three months program of yoga and diet counseling showed a significant (p<0.05; by utilizing paired T-test) decrease in systolic blood pressure (SBP) in post-intervention group as compared to pre-intervention group but no beneficial effects were observed in the other variables assessed. It was concluded that both yoga and diet counseling improved systolic BP in college-going young girls.

Keywords: Yoga, diet counseling, anthropometry, pain threshold, pain tolerance, oxygen saturation

Introduction
Modern lifestyle has lost the harmony in mind-body relationship and this is posing the greatest challenge to the health care system. Though modern medicine has proved effective in controlling infectious diseases yet today there is a rapidly increasing incidence of stress related lifestyle diseases such as hypertension, coronary heart diseases, cancer at a younger age than ever before. 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. The attempt to prevent and treat these diseases has triggered a search for better lifestyles and better strategies that converge on the rediscovery of ancient disciplines such as yoga combined lifestyles.

Yoga has made positive contribution to the physiological, psychological, sociological, spiritual parameters in humans. It has a scientific basis and is an inexpensive tool for improving the health indicators. The practice of Yoga in the Indian subcontinent has been documented as early as 500 B.C. Yoga is a psycho-somatic-spiritual discipline for achieving union of our individual consciousness with the universal consciousness. Regular practice of yoga has benefits in the improvement of the body, mind, and spirit, guiding to a healthier and more fulfilling life. When a person practices yoga, with yogic attitude (attitude of patience, persistent practice, overcoming obstacles within self, that is, overcoming laziness, anger, delusion, and desire for being different or better than others), there are several changes in physiology. It synchronizes human physiology through controlled postures, breathing, meditation, a set of regular physical exercises, and relaxations [1-4]. Compared to physical exercise yoga may be more effective or even better in improving health. The yoga resulted in health benefits, including improved immunity, cognition, respiration, joint disorders as well as reduced cardiovascular risk, body mass index (BMI), blood pressure (BP), diabetes mellitus. All over the world researchers have extensively studied yoga and reported that it increases longevity [5-8].

Yoga practitioners showed improvement of the memory performance, as well as improvements in psycho-physiological parameters. It also has therapeutic and rehabilitative effect [9-11]. Certain types of yoga practice improve autonomic nervous system by modulating parasympathetic and sympathetic activity, significant changes in brain rhythms, sensory motor rhythm, regulation of breathing rate, and improvement in the cardiac activity and enhance the sense of "well-being" [12-13]. Yoga has various benefits e.g. increase of heart rate variability, decreased BP, and increase in respiratory rate and baro-reflex sensitivity and balances autonomic nervous system activity by reducing sympathetic activity and increasing parasympathetic activity [1]. It is a simple, inexpensive method of overcoming the stress and the consequent complications. It is believed that the practice of yoga can also result in changes in perception, attention, and cognition. Investigations have shown the beneficial effects such as increased performances on visual and verbal memory and improved memory scores [14]. In a RCT conducted at All India Institute of Medical Sciences, Delhi, India, showed that adding a comprehensive yoga-based mind-body intervention to the conventional treatment improved several measures of pulmonary function in subjects having mild to moderate bronchial asthma, a decrease in exercise-induced broncho-constriction in the yoga group, particularly in the exercise-sensitive subjects [15]. A cross-sectional survey demonstrated long-term yoga meditation practitioners experienced better quality of life and functional health than the general population [16].

Researchers have revealed that during college years, there is a high involvement of young adults in unhealthy behaviors that may impact their nutritional and health status [17-22] but this is also a stage which has a high potential for positive behavior changes via lifestyle interventions [23]. Studies relating to lifestyle interventions focusing on targeted nutrition and dietary habits of college students [24-30] self-regulation strategies [28, 31-32], weight related health behaviors [33-36], improvement in physical activity [37-39] have shown some improvement in the dietary and physical activity habits of the college students. The duration of the intervention in these research studies ranged from 1 month to 7 months.

Though interventions based on singular approaches such as yoga training and diet counseling have shown to bring about improvements in the health status of individuals, lifestyle interventions that focus on multiple factors such as nutrition, physical activity and health awareness may prove to be more effective. Despite corpus of research on the subject, the lack of evidence based scientific approaches has limited the application of yoga as an accepted method for improvement of health. Hence further evidence-based research is needed on the impact of yoga and its potential benefits on physiology of healthy subjects. The physiological effects of yoga were reviewed in a previous issue of this journal [40], however, as there were no studies reported on additive effect of diet counseling and yoga on physiological parameters, it was an interesting area to explore. Similarly exploring the effects of yoga and diet counseling on pain modulatory system would be invaluable too.

The specific objectives of the present study were

1. Development of an integrated intervention package including yoga training and diet counseling and its implementation on young college-going females.
2. Assessment of the physiological effect of the intervention package on the target group after its implementation for 3 months.

Materials and Methods

This prospective study examined the additive effect of yoga training and diet counseling on various physiological parameters. The students of one constituent college of the University of Delhi were invited to participate in the study. A written informed consent was taken from those students who agreed to participate in the study. A total of 100 students were initially recruited, however, only 60 female undergraduate students completed the full intervention for 3 months. Various assessments such as weight, height, waist and hip circumference, blood pressure, pulse rate, oxygen saturation and pain perception test were carried out at baseline and after 3 months of intervention in the subjects. BMI and waist-hip ratio (WHR) of the subjects were also computed at baseline and after the 3-month intervention period.

Measurements

A portable electronic weighing scale with a capacity of 120kg and sensitivity of 0.1kg was used for weight measurement. Height and waist and hip circumferences were measured with the help of a non-stretchable, flexible measuring tape. Standard techniques were used for all measurements. BMI was calculated as weight (in kg) divided by height^2 (in meters^2) and WHR was computed as waist circumference (cm) divided by hip circumference (cm). Pulse Rate and Oxygen Saturation were noted after 5-10 minutes of rest in a sitting position, on right finger using pulse oximeter PO 04, displaying SpO_2 and pulse rate. BP measurement was standardized in a sitting position, right arm and was carried out using a validated automated BP monitor after 5-10 minutes of rest. Cold pressor test was used to measure pain threshold and pain tolerance. Participants were asked to place their hand in cold ice water (4 °C) for as long as they could. Once the pain was present, they let the researcher know. This provided a measure of pain threshold. Once the pain was unbearable, the participant removed her hand which was noted as pain tolerance.

Intervention

An intervention package comprising sessions on yoga training and diet counseling was designed for the study participants. The type of yoga practiced in the present study was *Surya-namaskar*/Sun salutation. It is relatively easy to perform as compared with other forms of yoga and is suitable for all ages and levels of fitness. It consists of a set of 12 powerful yoga asanas (postures) that provide a good cardiovascular workout. These postures are a good way to keep the body in shape and the mind calm and healthy. *Surya Namaskar* is best done early morning on an empty stomach. Study participants were divided into two smaller groups, each consisting of 25-30 participants. Each group met six days a week for 60 minutes at the Yoga Centre of the college to practice yoga with a yoga instructor.

Six diet and nutrition counseling sessions were designed for the study participants focusing on different dietary guidelines for Indians and other important diet and nutrition-related issues such as overweight/ obesity and physical activity, eating disorders, concept of balanced diet, etc. These sessions were conducted once in a fortnight in small groups of 25-30 students each. The duration of each session was 45 minutes to 1 hour. Power point presentations were used to explain all the concepts. Role play and discussions were carried out to make the sessions interesting. The sessions were highly interactive and encouraged questions from the participants. At the end of each session, some suitable printed material such as leaflet, folder, bookmark etc. focusing on the day's theme was distributed as a take-home message.

Statistical Analysis

The data obtained from the participants were subjected to analysis using suitable statistical formulae and tests. Mean and standard deviations were calculated for all physiological parameters. Pre-intervention and post-intervention changes in physiological parameters were assessed using the 't' test. The software SPSS (Statistical Package for Social Sciences) version 20.0 was used for the analysis of data.

Results

The mean age of the undergraduate college-going subjects in the study sample was 19.05±0.98 years. The effect of the 3-month intervention package of yoga training and diet counseling on the physiological parameters of the subjects has been presented as follows:

Effect on body weight, height and BMI

Body weight and height were recorded in the subjects at the time of their recruitment in the study and after 3 months of intervention. The statistical analysis indicated no difference in the post-intervention body weight (55.12±11.56 Kg) as compared to pre-intervention weight of the subjects (55.38±11.48 Kg). No significant difference was observed in the height of the subjects after intervention as compared to their height before intervention (Table I). BMI was computed for the subjects and during the period of observation, BMI variation was statistically not significant in post-exposure group (22.32±4.75 Kg/m^2) as compared to pre-exposure group (22.42±4.68 Kg/m^2) (Table I, Figure 1).

Table I: Effect of yoga and diet counseling on weight, height and BMI

Parameter	Total (n=60)		P value
	Pre-intervention Mean±SD	Post-intervention Mean±SD	
Weight (Kg)	55.38±11.48	55.12±11.56	0.327
Height (cm)	157.26±6.69	157.28±6.71	0.321
BMI (kg/m^2)	22.42±4.68	22.32±4.75	0.333

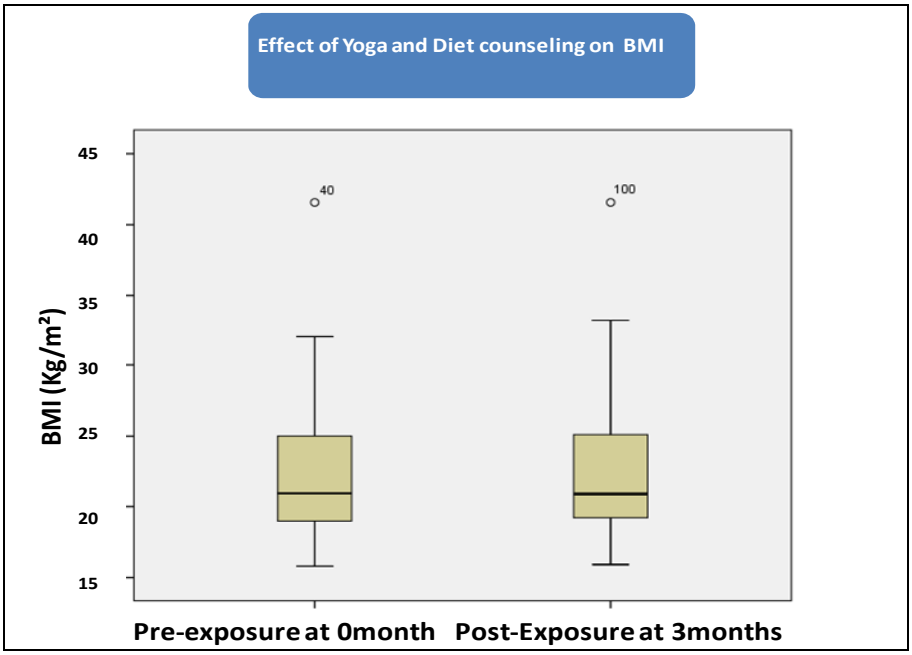

Fig 1: Depicts that BMI shows no significant variation in pre-exposure versus post yoga exposure group at 3 months

Effect on Waist/ Hip circumference and WHR

Waist circumference did not vary significantly in the subjects (74.11±8.98cm to 73.47 ± 9.23cm) at the end of 3 months of observation. Statistical analysis indicated no difference in the hip circumference in post-intervention group (94.15±9.72cm) at 3 months as compared to pre-intervention group (94.43±9.45cm) (Table II). Waist hip ratio varied from 0.787±0.080 to 0.781±0.078 during the 3-month period of observation in college going females. Statistical analysis indicated no difference in the post-intervention group as compared to pre-intervention group (Table II, Figure 2).

Table II: Effect of yoga and diet counseling on waist and hip circumferences and Waist Hip Ratio

Parameter	Total (n=60)		P value
	Pre-intervention Mean±SD	Post-intervention Mean±SD	
Waist circumference (cm)	74.11±8.98	73.47±9.23	0.090
Hip circumference (cm)	94.43±9.45	94.15±9.72	0.507
Waist Hip Ratio	0.787±0.080	0.781±0.078	0.238

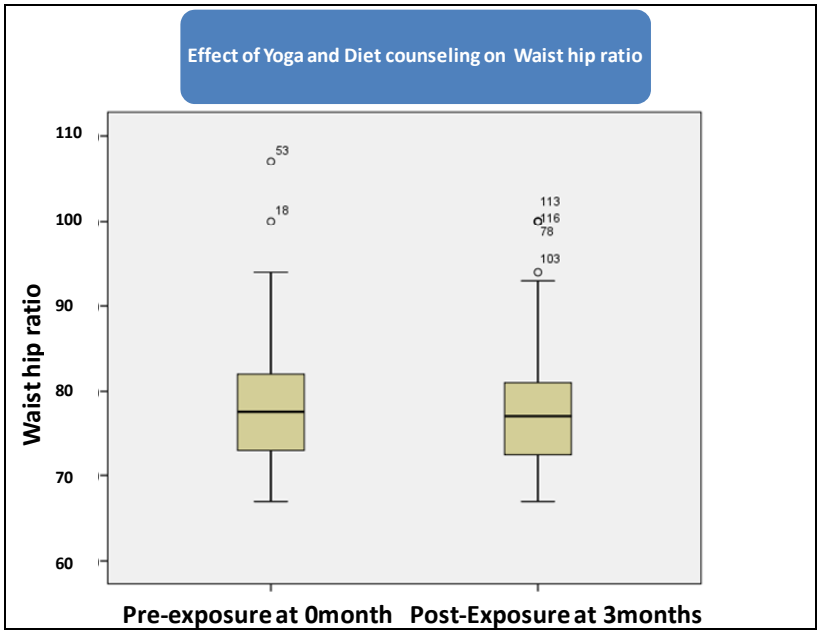

Fig 2: Depicts that waist hip ration shows no significant variation in pre-exposure versus post yoga exposure group at 3 months

Effect on Blood Pressure and Pulse Rate

The statistically significant reduction (p value-0.049) in Systolic blood pressure (111±14.35mmHg) was noted after 3 months of yoga and diet counseling when compared to that before the administration of intervention package (114 ±13.74mmHg) (Table III, Figure 3). Statistical analysis indicated no difference in the Diastolic blood pressure in post-intervention group (71±9.56mmHg) as compared to pre-intervention group (73±9.07mmHg) throughout the period of observation (Table III).

Pulse rate was recorded at 0 month and at 3 months with the help of pulse oximeter. No appreciable difference was noted in the pulse rate in post-intervention group (92±12.43/minute) as compared to pre-intervention group (92±12.67/minute) (Table III).

Table III: Effect of yoga and diet counseling on blood pressure and pulse rate

Parameter	Total (n=60)		P value
	Pre-intervention Mean±SD	Post-intervention Mean±SD	
Systolic BP (mmHg)	114±13.74	111±14.35	0.049*
Diastolic BP (mmHg)	73±9.07	71±9.56	0.208
Pulse Rate (per minute)	92±12.67	92±12.43	0.786

*indicates comparison between pre-intervention group and post-intervention values and denotes $p<0.05$ which is statistically significant

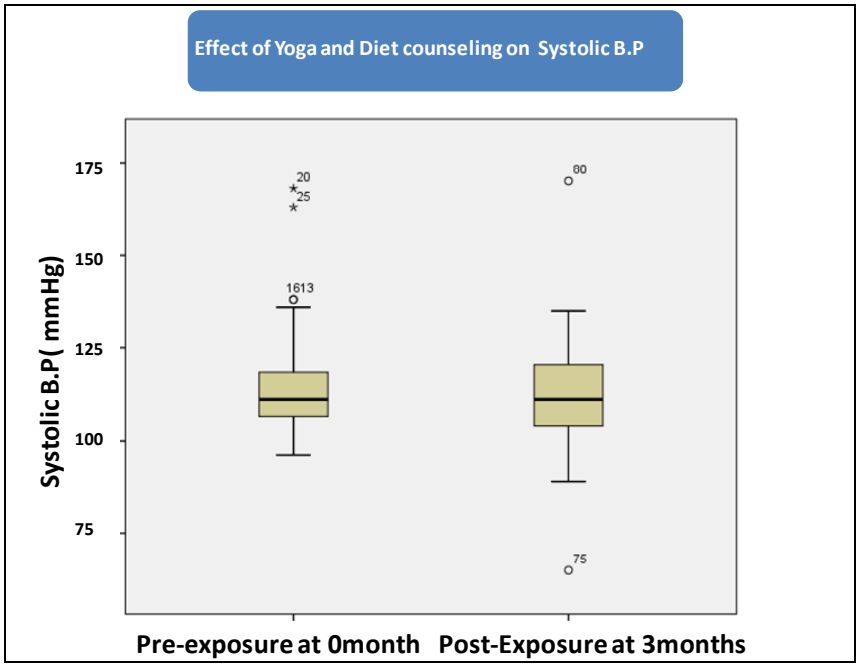

Fig 3: depicts that systolic BP shows statistically significant variation in pre-exposure versus post yoga exposure group at 3 months

Effect on Pain Threshold and Pain Tolerance

Pain threshold did not vary as a function of time and intervention in post-exposure group (15.23±7.07seconds) as compared to pre-exposure group (15.23±7.74seconds). Also, in post-intervention group, pain tolerance variation did not attain significance as compared to pre-intervention group (Table IV).

Table IV: Effect of yoga and diet counseling on pain threshold, pain tolerance and oxygen saturation

Parameter	Total (n=60)		P value
	Pre-intervention Mean±SD	Post-intervention Mean±SD	
Pain threshold (seconds)	15.23±7.07	15.23±7.74	1.000
Pain tolerance (seconds)	30.18±15.47	27.05±13.35	0.088
Oxygen saturation (%)	98.68±0.98	98.68±0.79	1.000

Effect on Oxygen Saturation

Effect of yoga and diet counseling on oxygen saturation did not attain significance at three months as compared to pre-intervention group during the period of three months (Table IV).

To summarize, our results showed that intervention of a yoga and diet counseling resulted in statistically significant lowering of systolic blood pressure but other physiological parameters studied did not vary as a function of time and intervention in post-intervention group as compared to pre-intervention group.

Discussion

The novelty of the present study is that it observed the additive effect of yoga and diet counseling on health parameters in a young healthy college going females. The practice of yoga can improve physiological parameters like blood pressure and provide sustainable health. The significant reduction in the systolic BP as recorded in the present study is in line with the earlier studies. Previous studies have also shown that yoga may reduce BP. [41-44] these studies showed significant reduction of SBP of up to 6 mmHg and a significant reduction of diastolic BP (DBP) of up to 5 mmHg compared to baseline. [41, 43-44] The present study confirmed the positive effects of yoga and diet counseling in lowering the SBP but not on the DBP and pulse rate. Whether these results are clinically significant remains an unanswered question but yoga as a BP lowering modality may be recommended as Complementary and Alternative Medicine (CAM). CAM is a rapidly evolving field of medicine that consists of therapy used as an alternative to conventional therapy. The CAM therapies include major therapeutic lifestyle changes (TLCs) which are accessible, effective and cost effective when used alone or adjunctively. [45-46] Some TLCs, for example, exercise, diet, yoga and meditation may become healthy sustainable habits. [47] BP is influenced by input from both the parasympathetic and the sympathetic systems. [48] Hemodynamic derangements, an increased neuro-hormonal activation via the sympathetic nervous system and the renin-angiotensin system has been implicated in the hypertension. In our study, addition of yoga therapy and diet counseling resulted in a significant decrease in the SBP and thus, a shift towards parasympathetic predominance and attenuation of the deranged autonomic nervous system.

Previous researchers have shown that yoga also increases oxygen saturation. The level of Oxygen Saturation and Vital Capacity of school going children have been increased followed by a regular three months practice of *Surya Namaskar* [49]. In our study effect of yoga and diet counseling on oxygen saturation did not attain significance at three months as compared to pre intervention group. However, this could be due to high baseline oxygen saturation level in our young college going subjects (Table IV).

At the time this study was conceived, data from several observational and experimental studies suggested that yoga, either alone, or as part of a more comprehensive lifestyle program including dietary changes, may promote weight loss [50-54] or attenuate weight gain [55]. Anthropometric measurements are essential and reliable tools for evaluation of malnutrition, muscular mass loss, fat mass gain and adipose tissue redistribution. The present trial demonstrated no statistically significant changes in anthropometric variables, body weight, height, waist circumference, hip circumference, WHR and BMI following 3 months of yoga and diet counseling. The lesser magnitude of change may be attributed to a lower initial BMI of our participants (22.42±4.68 kg/m^2) and relaxed practice schedule. The study provides a positive trend towards normalcy even though the magnitude of change (22.32±4.75 kg/m^2) was not statistically significant. However, this study's ability to detect differences was limited by the short study duration and the small sample size. A longer, more intensive intervention may be needed to see weight loss. Various studies suggest that behavioral treatment for weight loss is recommended for at least 6 months [56] and longer programs lead to greater weight loss than shorter programs [57]. The present study with 3 months of yoga and diet counseling showed no change in the waist hip ratio. These results suggest that there was no difference in the reductions in fat stored centrally inside the abdomen (waist circumference) and in fat stored peripherally (hip circumference) with the yoga and diet counseling interventions. These contradictory findings could be due to small sample size and the lack of separate evaluation of two interventions.

Several studies have examined yoga as a potential treatment for pain and found beneficial effect of yoga to treat different painful conditions [58]. Both attentional and emotional factors influence pain perception [59, 60, 61]. As yoga encourages an emotionally detached observation of the present moment therefore, it has been shown to improve mindfulness scores, [62] associated with improved pain tolerance [63]. The emotional and cognitive tools of yoga modulate pain perception, by strengthening affective reaction to pain. However, the additive effects of yoga and diet counseling on experimental pain perception have yet to be explored. Therefore present study evaluated the effect of yoga and diet counseling on pain perception variables. Pain threshold and pain tolerance did not vary as a function of time and intervention in post exposure group as compared to pre-exposure group.

Limitations and Future Directions

The present study demonstrated benefits of both yoga and diet counseling on systolic BP. However, the findings are limited by the following factors: (i) the anthropometric and physiological parameters were evaluated in a small sample due to constraint of time and funds allocated by the funding agency. (ii) The absence of a control group limits attributing changes seen to either yoga or diet counseling or both. (iii)

The high dropout rate, which was due to factors such as lack of compliance with the program and personal reasons requiring them to leave before the 3months were complete. (iv) The groups included participants whose metabolism would be influenced by different physiological factors. (v) The interventions were 3 months in duration and it was not possible to determine whether the effects extended beyond that period or not. These limitations suggest possible directions for future study in this area of considerable medical concern.

Conclusion

The analysis of our results clearly indicated that yoga and diet counseling had significant effect on the systolic BP of young college-going females.

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