Original Article

Efficacy of a Short-Term Yoga-Based Lifestyle Intervention in Improving Cognition in Overweight/Obese Subjects

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Abstract

Background and Aim: The present report was designed to evaluate the efficacy of a short-term yoga-based lifestyle intervention in modifying cognitive functions and brain activity during cognitive tasks in overweight/obese patients. **Methods:** A total of (n = 12) Overweight/Obese patients and (n = 9) healthy controls who attended a short-term yoga-based lifestyle intervention program were recruited for the study. Anthropometric parameters include height, weight, body mass index (BMI), and systolic and diastolic blood pressure; different cognitive domains include Controlled Oral Word Association Test, Symbol Digit Modalities Test, Verbal n-back Test, and Forward/backward digit span; self-report measures include the Freiburg Mindfulness Inventory and Centre for epidemiologic studies for depression scale and electroencephalography (EEG) activity during different cognitive tasks were carried out twice, i.e. day 1 (baseline) and day 14 (end of intervention). **Results:** Significant ($P < 0.05$) improvement was observed for weight, BMI, mindfulness scores, n-back test, and total attention span following lifestyle intervention for overweight/obese patients. Furthermore, EEG activity showed significant ($P < 0.05$) increase in alpha, beta, and theta absolute power at the end of intervention. Parameters for control group remained comparable at day 14 versus day 1. **Conclusion:** Findings suggest that a short-term yoga-based lifestyle intervention may significantly improve cognitive functions and brain activity in overweight/obese patients.

Keywords: Cognition, electroencephalography, Freiburg mindfulness, obesity, overweight, short-term lifestyle intervention program

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Introduction

Cognition is the mental processes involved in gaining knowledge and comprehension. These processes include thinking, knowing, remembering, judging, and problem solving.[1] Previous studies showed that overweight and obesity are associated with poor cognitive performance, cognitive decline, and dementia at different ages.[2-4] Various possible mechanisms have been proposed to explain this relationship. It has been projected that poor control of neural centers in relation to addiction might promote impaired control of food intake, leading to overeating, and subsequent overweight.[5] On the other hand, overweight and obesity associated with inflammation (both systemic and central) and vascular changes, as well as decreasing the volume of white matter which might impair general cognitive performance in some cognitive areas associated with learning and memory.[6] Studies have also been conducted to show the changes in brain activity during challenging cognitive tasks following intervention.[7,8]

Overweight patients are likely to have poor physical and mental functioning status that affects their quality of life which are important issues in public health and interventions at this level should be addressed to promote healthy living.[9] Studies have been conducted to reveal that a lifestyle modification and relaxation techniques that include meditation have shown improvements on cognitive performance.[10-13] Nevertheless, to the best of our knowledge, no studies have yet assessed the possible influence of short-term yoga-based lifestyle

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intervention on cognition in overweight/obese patients. Therefore, the present study was designed to assess the efficacy of a short-term yoga-based lifestyle intervention on different cognitive functions and to observe the changes in brain activity during different cognitive tasks in overweight/obese patients.

Materials and Methods

This was a prospective interventional study with pre- and postdesign. A total of 30 overweight/obese patients and healthy controls were initially enrolled in the study between July 2012 and December 2013. Out of the 30 patients, 5 declined to participate, and 4 patients did not come for tests for the past day of the intervention, i.e. day 14, therefore, a total of 21 patients completed the study. Overweight/obese patients (Group A; n = 12; males = 5; females = 7) (body mass index [BMI] for overweight 23.0–24.9 kg/m^2 and obesity ≥25.0–35.0 kg/m^2 as per the WHO cutoff values for Asians)[14] underwent 2 weeks of short-term yoga-based lifestyle intervention at the Integral Health Clinic (IHC), Department of Physiology, all India Institute of Medical Sciences (AIIMS), New Delhi. The control group included 9 healthy controls (Group B, males = 2; females = 7) who had not attended any such program in the past 1 year and were recruited among the hospital staff and patients' attendants. Exclusion criteria included those having dementia, vision and hearing challenged patients, and pregnant woman.

The study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee of Institutional Review Board, AIIMS, New Delhi. All the patients provided their written informed consent.

The pretested[15] IHC intervention consists of a short-term lifestyle intervention program that includes yogasana (physical postures); breathing exercises; meditation; group discussions; and individual advice on stress management, diet, and physical activity in addition to group support. Each session lasted about 2 h per day for 10 days spread over 2 weeks. Routine clinical and laboratory variables were measured before and after the intervention. The self-report were assessed using (a) Freiburg Mindfulness Inventory[16] (14-item), a psychometrically valid instrument that measures the mindfulness experience with internal consistency (Cronbach alpha = 0.93). Scores range from 14 to 56 and higher scores indicate a greater degree of mindfulness; (b) Centre for epidemiologic studies for Depression scale,[17] a well-validated, 20-item, scale that measures depressive symptomatology. This validated self-report scale has a high internal consistency with alpha coefficient of 0.85. Scores range is 0–60. Higher scores indicate the higher levels of depression. The cognitive function tests were assessed using different cognitive domains which include (a) Controlled Oral Word Association Test (COWAT)[18] measures the verbal fluency in which patients were asked to say as many words as they could think of beginning with the letters "F, A, and S," or "C, F, and L" within 1 min. The dependent measure is the total number of words produced; (b) Symbol Digit Modalities Test (SDMT)[19] measures the complex visual tracking and working memory that requires decoding of a series of numbers listed on paper according to a corresponding template of visual symbols. With the use of a reference key, participant was given 90 to accurately match numbers with corresponding geometric figures. The dependent measure is number of symbols coded minus errors; (c) Verbal working memory (verbal n-back test),[20] to measure information processing speed, verbal working memory, and attention; (d) Forward/backward digit span (Wechsler Adult Intelligence Scale-Revised[21] was used to measure immediate memory span. The dependent measures are total forward digit span and total backward digit span. In the forward digit span, patients can correctly repeat back a span of up to 16 digits. In the backward version, patients can recite back a span of up to 14 digits backward. Higher scores indicate the higher memory recall.

Changes in the brain activity was assessed using (19) channel electroencephalography (EEG) system (NEUROWERK, Sigma Medizin-Technik GmbH, Germany) with Au-AuCl (Gold) electrodes using International 10–20 montage system, reference to the linked ear lobes. The EEG signals were quantified using frequency spectral analysis for each condition. Artifact-free epochs were selected for every 5 min of EEG recording for each condition and then, a mean FFT calculation was done to produce a frequency spectrum. The different band frequencies were identified as alpha (8.0–12.9 Hz), theta (4.0–7.9 Hz), beta (13.0–30.0 Hz), and delta (<4 Hz). The quantitative report shows peak frequency (Hz) and absolute power (μV^2) of different EEG waves. The study design flowchart is shown in Figure 1. The same assessments were made for control group within 14 days window period. All the assessments were done between 8:30 and 9:30 AM.

Statistical analysis of data

SPSS software was used (version 22.0) (SPSS Software Inc., Chicago, IL, USA) for statistical analysis. All the study parameters for both the Groups (A and B) on day 14 and day 1 were compared using "Wilxocon Signed Ranks" Test.

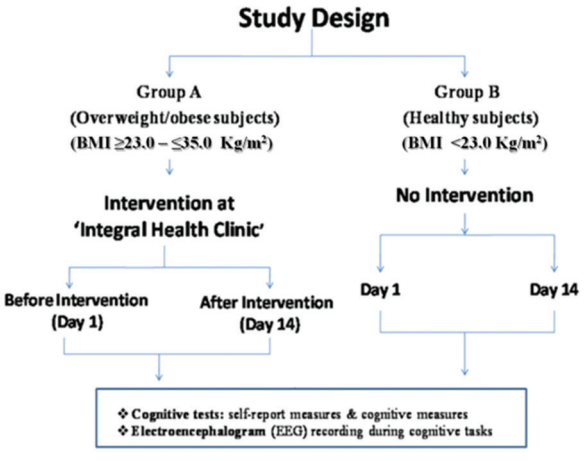

Figure 1: Study design flow chart

Results

The anthropometric parameters, changes in cognitive domains, and brain activity are presented in Table 1. The present study showed a significant weight-loss ($P = 0.01$), with a significant BMI reduction ($P = 0.04$) at day 14 versus day 1. Following intervention, the mindfulness scores ($P = 0.004$), COWAT scores ($P = 0.01$), total attention span scores ($P = 0.002$), and SDMT scores ($P = 0.005$) were improved significantly at day 14 versus day 1. For 1-Back test, the number of errors was reduced significantly ($P = 0.04$) at day 14 versus day 1, but the total number of hits was found to be remaining same. On the other hand, for 2-Back test, the number of errors was reduced significantly ($P = 0.01$) with increased number of hits significantly ($P = 0.01$). The control group did not show any changes in cognitive functions. Overall, the order of cognition was found to be changed in a positive direction at the end of intervention, i.e. day 14 for the overweight/obese patients.

EEG recording showed that alpha absolute power ($P = 0.025$), alpha peak frequency ($P = 0.013$), theta absolute power ($P < 0.001$), and beta absolute power ($P = 0.03$) were increased significantly, whereas delta peak frequency ($P = 0.002$) was decreased significantly for overweight/obese patients at day 14 versus day 1 [Table 1]. For control subjects, the delta absolute power was found to be decreased significantly at day 14 versus day 1. The representative EEG recording for overweight/obese patients is shown in Figure 2.

Table 1: Demographic characteristics, self-reports measures, cognitive domains, and electroencephalography changes observed during cognitive tasks at day 1 versus day 14 for Group A and Group B

Parameters	Group A (overweight/obese subjects)		*P*	Group B (healthy subjects)		*P*
	Day 1	Day 14		Day 1	Day 14	
Number of subjects (*n*)	12	-	-	9	-	-
Age (years)	40.5 (28.0-55.0)	-	-	39.5 (29.0-51.0)	-	-
Height (cm)	164.5 (146.0-172.5)	-	-	162.1 (149.2-169.5)	-	-
Weight (kg)	67.85 (50.10-102.6)	67.35 (49.8-100.5)	0.01	57.9 (50.1-62.0)	57.5 (49.8-61.5)	0.55
BMI (kg/m^2)	24.67 (23.13-36.0)	24.23 (23.09-35.26)	0.04	21.8 (19.57-22.50)	21.9 (20.10-22.40)	0.47
Systolic blood pressure (mmHg)	124.0 (102.0-134.0)	120.0 (96.0-138.0)	0.58	116 (110.0-124.0)	114.0 (110.0-120.0)	0.10
Diastolic blood pressure (mmHg)	84.0 (74.0-100.0)	86.0 (80.0-90.0)	0.43	76.0 (72.0-124.0)	80.0 (70.0-86.0)	0.76
Self-reports measures						
Mindfulness scores	36.5 (26.0-47.0)	40.0 (30.0-46.0)	0.004	34.0 (26.0-47.0)	35.0 (30.0-46.0)	0.06
CES-D scores	15.5 (9.0-41.0)	15.2 (9.0-35.0)	0.13	15.0 (8.0-41.0)	15.0 (9.0-42.0)	0.31
Cognitive domains						
COWAT scores	7.0 (3.0-14.0)	10.0 (4.0-17.0)	0.01	6.0 (3.0-14.0)	6.0 (4.0-17.0)	0.41
SDMT scores						
Total time required to complete the test (s)	420.0 (220.0-490.0)	375.0 (210.0-488.0)	0.16	420.0 (372.0-480.0)	390.0 (312.0-510.0)	0.61
Scores obtained during test	84.0 (14.0-91.0)	88.5 (52.0-98.0)	0.005	86.0 (73.0-94.0)	92.0 (52.0-98.0)	0.16
N-back test						
1-back test						
Number of hits	7.5 (6.0-9.0)	7.5 (6.0-10.0)	0.13	7.0 (5.0-9.0)	7.0 (6.0-10.0)	0.19
Number of errors	3.0 (1.0-4.0)	2.5 (0.0-4.0)	0.04	3.0 (1.0-5.0)	3.0 (0.0-4.0)	0.19
2-back test						
Number of hits	8.0 (2.0-10.0)	9.5 (5.0-10.0)	0.01	8.0 (2.0-9.0)	8.0 (5.0-10.0)	0.12
Number of errors	2.0 (0.0-8.0)	0.0 (0.0-5.0)	0.01	2.0 (1.0-8.0)	2.0 (0.0-5.0)	0.08
Attention span						
Forward digit span	8.5 (5.0-16.0)	11.5 (8.0-19.0)	0.001	11.0 (5.0-18.0)	10.0 (8.0-19.0)	0.06
Backward digit span	5.0 (3.0-9.0)	7.5 (4.0-13.0)	0.007	4.0 (3.0-7.0)	5.0 (2.0-13.0)	0.05
Total attention scores	13.5 (9.0-25.0)	18.5 (12.0-29.0)	0.002	15.0 (9.0-25.0)	15.0 (10.0-32.0)	0.21
EEG changes						
Alpha peak frequency (Hz)	8.43 (7.6-10.8)	10.2 (8.0-11.8)	0.013	8.90 (8.0-12.0)	9.0 (8.0-12.50)	0.15
Alpha absolute power (μV^2)	14.65 (8.29-41.92)	20.15 (10.07-60.21)	0.025	14.07 (8.36-34.33)	15.0 (9.0-25.0)	0.24
Theta peak frequency (Hz)	4.27 (4.01-7.21)	4.35 (4.2-7.51)	0.06	4.29 (4.0-6.10)	4.27 (4.0-6.0)	0.23
Theta absolute power (μV^2)	13.24 (4.61-46.52)	24.8 (7.41-51.24)	0.001	13.93 (2.91-48.13)	13.23 (4.77-42.75)	0.06
Beta peak frequency (Hz)	19.3 (14.2-31.0)	20.5 (15.0-31.6)	0.06	18.95 (13.0-27.27)	19.1 (13.0-32.0)	0.07
Beta absolute power (μV^2)	26.42 (12.71-64.09)	28.02 (19.49-67.22)	0.03	19.98 (13.84-40.45)	21.0 (8.40-46.0)	0.469
Delta peak frequency (Hz)	1.94 (0.61-3.62)	1.02 (0.04-3.65)	0.002	2.0 (0.10-4.0)	1.98 (0.01-3.60)	0.43
Delta absolute power (μV^2)	2.54 (1.38-4.04)	2.86 (102-3.09)	0.26	3.95 (1.71-5.73)	3.23 (0.39-17.05)	0.05

All the values are in median (range); Wilcoxon signed ranks test, *P* value between day 1 and day 14. EEG: Electroencephalography, CES-D: Centre for Epidemiologic studies for Depression Scale, COWAT: Controlled oral word association test, SDMT: Symbol digit modalities test, BMI: Body mass index

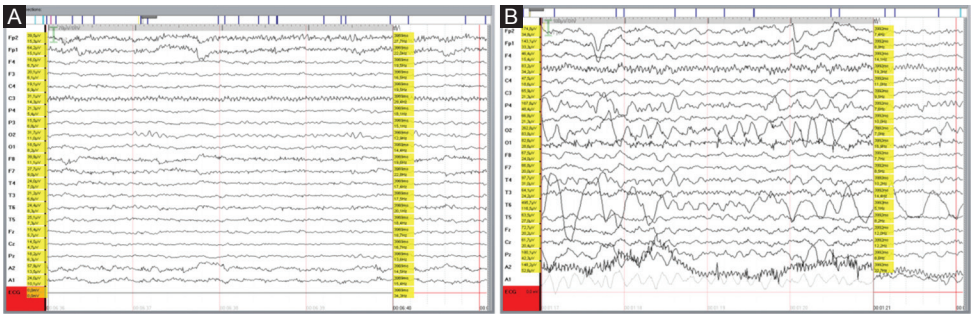

Figure 2: Electroencephalography record for overweight/obese patients during cognitive tasks at baseline (day 1; Record A) and at day 14 (end of the intervention; Record B) with eyes opened, respectively

Discussion

The intervention in the study was a short-term, yoga-based lifestyle intervention comprised simple *asanas* (postures), *pranayama* (breathing exercise), meditation, stress management, and other aspects of lifestyle. In the present study, overweight/obese group showed significant decrease in body weight and BMI at the end of intervention. Furthermore, showed significant improvement from the baseline (day 1) performance in working memory, verbal fluency, visual coding, sustained attention, and increased mindfulness after the study period of 14 days, suggesting that short-term lifestyle intervention program has a potential efficacy to influence mindfulness and well-being, which might be clinically useful in treating conditions such as depression and anxiety as well as executive functions for overweight/obese patients.

The present study also examined the changes in the brain electrical activity recorded simultaneously during cognitive tasks and observed that there were significant increases in the alpha power, theta power, and beta power from the baseline recordings. Increased theta activity is associated with attentiveness, awareness, orientation, working memory, and affective processing;[22] increased alpha activity relates to relaxation, whereas beta activity relates to logical thinking, and active conversation.[23] These results are in line with the previous studies.[7,24] As expected, little change is produced in delta (sleep or pathological processes) following lifestyle intervention.

The main limitation of the present study is the small sample size. However, the findings from this study are notable as this is the first brief report that evaluates the influence of short-term yoga-based lifestyle intervention on cognitive functions and changes brain activity during cognitive tasks in overweight/obese patients.

Conclusion

The present findings will help overweight/obese patients to overcome the deleterious cognitive functions including problems with thinking, memory, concentration, and behavior and make their cognitive skills sharper. Furthermore, overall stress has been found to be reduced by observing the increased mindfulness scores and increased alpha activity which relates to relaxation.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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