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Original Research Article

Effect of surya namaskar on anthropometric parameters and serotonin level in apparently healthy subjects

Himani Hanumant More[1]*, Ajaya Deep Singh[2], Archana Ghildiyal[3]

[1]Department of Physiology, Autonomous State Medical College, Amethi, Uttar Pradesh, India
[2]Community Health Centre, Ayodhya, Uttar Pradesh, India
[3]Department of Physiology, King Georges Medical University, Lucknow, Uttar Pradesh, India

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***Correspondence:**
Dr. Himani Hanumant More,
E-mail: himanimore541@gmail.com

ABSTRACT

Background: Although surya namaskar was not considered an asana or part of classical yoga, it is now part of modern yoga practise. It consists of twelve postures. Surya namaskar has a profound calming effect and helps to detoxify the deep-seated organs through abundant oxygenation. The purpose of this study was to investigate how surya namaskar affects anthropometric measures, serotonin levels, and anxiety (as measured by the DASS 21 score).
Methods: Using inclusion and exclusion criteria, 80 healthy overweight participants (BMI of 23.0-24.9 kg/m^2) were selected for the study. They were between 20 and 45 years of age. The subjects practiced surya namaskar 5 days a week for 6 months. Anthropometric characteristics such as height, weight, waist, hip and sagittal abdominal circumference were measured before and surya namaskar sessions. The psychological status of the patients was then assessed using the DASS-21 questionnaire at the time of subject enrolment and after 6 months of surya namaskar.
Results: After surya namaskar, there were significant changes in weight (kg), waist circumference (cm), BMI (kg/m^2), sagittal abdominal circumference (cm), and WHR were significantly reduced. Hips circumference was mildly increased. Increase in serotonin levels was seen. After surya namaskar, mild depression, severe anxiety and moderate stress were significantly reduced.
Conclusions: Surya namaskar has an effect on the physiological, psychological and physical properties of the body. It is recommended to apply surya namaskar in clinical settings to treat psychological stress and obesity.

Keywords: Anxiety, Depression, Overweight, Stress, Surya namaskar

INTRODUCTION

Surya namaskar or the 'sun salutation' is a set of dynamic postures, that despite not being considered as a formal yogic asana, it is complete exercise having positive impact on physical as well as mental well-being.[1] As per WHO, "health is a state of complete physical, mental and social well-being and not merely an absence of disease or infirmity".[2]

In 2017, 197 million Indians suffered from mental health disorders of whom 46 million had depression and 45 million anxiety disorders.[3] Serotonin/5-hydroxytryptamine (5-HT) is a monoamine neurotransmitter that plays a role in several complex biological functions.[4,5] The serotonin plays several biological roles in human body such as regulation of sleep, happiness, reward, learning, memory, sexual behaviour as well as physiological processes like appetite and behaviour.[6] Supplements of fluoxetine (a selective serotonin reuptake inhibitor) among patients of depression showed positive association between recovery of depression symptoms and circadian amplitude of salivary serotonin secretion.[7] National Institute for Health and Clinical Excellence preferred inclusion of exercise in

daily schedule of patient with mild depression over anti-depressants as risk-benefit ratio of antidepressants was poor. Exercise improves mood in subclinical and patients.[8]

Various studies have reported effect of yoga practice on pulmonary function and respiratory pressures, handgrip strength and endurance and cardiovascular parameters.[9-18] Shimpi et al had proposed that combination of surya namaskar along with physical education of exercise could offer higher benefits in school children.[19] Kaushik et al had reported that yoga along with meditation are effective for treatment of stress related disorders.[20]

Surya namaskar is a group of yogic exercise consisting of group of 12 postures. It involves pranayama, asana, upasana. These postures are performed dynamically in synchrony with breath.[21] The 12- pose sequence of surya namaskar are as follows: pose 1- salutation pose (pranamasana), pose 2- raised arm pose (hasta uttasana), pose 3- hand to foot pose (hasta padasana), pose 4- equestrian pose (ashwasanchalanasana), pose 5- mountain pose (parvatasana), pose 6- eight limb pose (ashtanganamaskara), pose 7- cobra pose (bhujangasana), pose 8- mountain pose (parvatasana), pose 9- equestrian pose (ashwasanchalanasana), pose 10- hand to foot pose (hastapadasana), pose 11- raised arm pose (hasta uttasana), pose 12- salutation pose (pranamasana).

Individual asanas have their own physical benefits which include stretching of thoracic, abdominal and intestinal muscles, lifting prana upwards in the body; massages the abdominal organs, tones spinal nerves and moves prana in the lower body parts; strengthens muscles of arms and legs.[22,23] Moody reported improvement in cardio respiratory fitness and weight management through regular practice of Surya Namaskar.[24]

The present study had been proposed to study the effect of surya namaskar on anthropometric parameters, serotonin levels and anxiety levels (DASS 21) score.

Aim

To assess the impact of surya namaskar on anthropometric, biological and psychological parameters.

Objective

Before and after 6 months training of surya namaskar- to measure anthropometric parameters, to measure anxiety score (DASS-21), to measure blood serotonin level. To evaluate the changes in blood serotonin levels. To correlate blood serotonin level to various anthropometric parameters of apparently healthy subjects. To compare anthropometric parameters anxiety score, blood serotonin level before and after 6 months of surya namaskar.

Study hypothesis

Surya namaskar has positive effects on mind and body.

METHODS

The study was conducted in department of physiology, King George's Medical University, Lucknow campus. Ethical clearance was obtained from the institutional ethics committee of KGMU, Lucknow.

Study design and period

This was a prospective interventional study that took place for a period of one year.

Sample size

A total of 80 cases were included in the study.

Inclusion criteria

Apparently healthy individuals with age group 20-45 years. Individuals not doing regular exercise with no addiction of smoking, tobacco or alcohol. BMI range with overweight (23.0-24.9 kg/m^2). Ethical approval was obtained from the institutional ethics committee.

Exclusion criteria

Any co-morbid conditions like asthma, renal impairment, arthritis. Subjects who were not regular for Surya namaskar sessions. Women having known gynaecological neoplasm requiring surgery or pregnant women. BMI ≥25 kg/m^2.

Written informed consent was obtained from the included participants. Subjects were described the purpose of study. Demographic details (age and sex) were noted. Assessment of anthropometric parameters like weight, height, waist circumference, hip circumference, sagittal abdominal circumference was made. Body mass index and waist hip ratio were calculated. Following this, assessment of psychological status of the patients was done using DASS-21 inventory. Physiological parameters like systolic and diastolic blood pressure, heart rate was measured using digital sphygmomanometer. Also, 2 ml blood specimen was collected from each participant under aseptic conditions. The blood samples were routed to department of biochemistry of KGMU, Lucknow for assessment of serotonin level.

Training and practice

All subjects were invited for initial orientation classes for surya namaskar. The orientation training was given in batches of 5 or more participants. The subjects were trained to perform surya namaskar in a slow manner so that each of the 12 postures was held for 30 seconds. Each round took 6 minutes to complete and five rounds were performed in 30-40 minutes.[17] Orientation programme was held for one week. A trainer was appointed for conducting the orientation as well as routine sessions of surya namaskar. Thereafter all participants were advised to do

the surya namaskar five days a week for next six months. Surya namaskar sessions were arranged via zoom meeting in morning at 6:30 everyday from Monday to Friday. Subjects used to join the meeting and perform the 12 postures under guidance of yoga instructor for 6 months.

At the end of six months, the anthropometric, biochemical and psychological assessment was done again.

Statistical analysis

The data obtained was fed into computer using Microsoft Excel 2017 software. Statistical analysis was done using IBM SPSS 21.0 software. Data has been represented as numbers and percentage for qualitative/categorical variables and as mean±standard deviation for continuous parameters. Paired 't' test and Wilcoxon signed rank tests were used to compare and evaluate the magnitude and significance of change in different anthropometric, biochemical, physiological/vital and psychological parameters.

Pearson Bihari ate correlation was performed to assess the correlation of change in serum serotonin with other parameters studied. The study was done at a 95% confidence. A 'p' value below 0.05 was considered as statistically significant.

RESULTS

All the subjects were personally interviewed to collect the demographic details and clinical history, thereafter physical examination and anthropometric parameters were measured and noted. Blood sample was taken for measurement of serotonin levels. Mean age of the population was 28.89 years with standard deviation (SD) of 3.87 years where 46.3% of the population was female and 53.8% found to be male.

Table 1: Change in anthropometric parameters of study population (n=80) after surya namaskar (paired 't' test).

	Weight (kg)		Waist circum. (cm)		Hip circum. (cm)		BMI (kg/m²)		Sag. abdominal diameter (cm)		WHR	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Pre surya namaskar	62.11	6.37	86.93	5.14	99.77	4.53	23.09	1.45	25.86	1.70	0.87	0.05
Post surya namaskar	60.44	6.17	85.74	4.95	100.40	4.35	22.46	1.47	24.78	1.31	0.86	0.05
Change	-1.68	1.32	-1.19	1.75	0.63	2.36	-0.63	0.45	-1.09	1.00	-0.01	0.03
% change	-2.70		-1.37		0.63		-2.72		-4.20		-1.65	
't'	-11.354		-6.066		2.394		-12.333		-9.765		-4.951	
P value	<0.001		<0.001		0.019		<0.001		<0.001		<0.001	

When compared with the help of paired 't' test, following changes were noted with respect to anthropometric parameters of population after 6 months of surya namaskar (Table 1).

Observations

Mean body weight of subjects before intervention of Surya namaskar was 62.11±6.37 kg which after intervention declined to 60.44±6.17 kg. A decline of 1.68±1.32 kg (2.70% of pre-intervention) in body weight was observed. This change was found to be significant statistically.

Pre-intervention mean waist circumference of subjects was 86.93±85.74 cm which after 6 months training and practice of surya namaskar was observed to be 85.74±4.95 cm. A change of 1.19±1.75 cm (1.37% of pre-intervention) was observed. This change was also found to be significant statistically.

A rise of 0.63±2.36 cm (0.63%) in hip circumference of subjects was observed after 6 months training and practice of surya namaskar. Hip circumference increased from 99.77±4.53 to 100.40±4.35 cm. This change was found to be significant statistically.

Pre-intervention BMI of subjects was 23.09±1.45 kg/m^2 which after intervention was found to be 22.46±1.47 kg/m^2. A decline of 0.63±0.45 kg/m^2 (2.72% of pre-intervention) in BMI was observed after 6 months training and practice of surya namaskar. This change was found to be significant statistically significant.

Sagittal abdominal diameter of subjects before intervention was 25.86±1.70 cm while same after 6 months training and practice of surya namaskar was 24.78±1.31 cm. A decline of 1.09±1.00 (4.20% of pre-intervention) in sagittal abdominal diameter was observed after 6 months. This change was significant statistically.

Mean waist hip ratio of subjects before intervention was 0.87±0.05 while that after intervention reduced to 0.86±0.05. A decline of 0.01±0.03 in waist-hip ratio was observed, which was 1.65% of pre-intervention WHR. Change in WHR was found to be significant statistically. Significant change in all the anthropometric parameters

was observed after intervention of surya namaskar for study period.

The change in serotonin level before and after the surya namaskar was compared by paired 't' test (Table 2).

Mean serotonin level of subjects before practice of surya namaskar was 0.068±0.014 µmol/l which rose to 0.075±0.015 µmol/l after 6 months of training and practice of surya namaskar. An increment of 0.007±0.017 µmol/l (10.34%) in pre-intervention serotonin levels was observed. This change was found to be statistically significant.

Table 2: Change in serotonin levels (µmol/l) of study population (n=80) after surya namaskar (paired 't' test).

	Mean	SD
Pre-serotonin level (µmol/l)	0.068	0.014
Post-serotonin level (µmol/l)	0.075	0.015
Change in serotonin level	0.007	0.017
% change	10.34	

't'=3.757; p<0.001

Table 3: Change in DASS score of study population (n=80) after surya namaskar (paired 't' test).

	Depression		Anxiety		Stress	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Pre	13.45	2.52	9.98	1.67	16.06	1.49
Post	10.53	1.95	9.33	1.56	12.91	1.72
Change	-2.93	1.81	-0.65	1.47	-3.15	1.96
% change	-21.75		-6.52		-19.61	
't'	-14.490		-3.961		-14.358	
P value	<0.001		<0.001		<0.001	

Table 4: Qualitative change in depression, anxiety and stress after surya namaskar (Wilcoxon signed rank test).

Participants with		Normal depression (0-9) anxiety (0-7) stress (0-14)		Mild depression (10-13) anxiety (8-9) stress (15-18)		Moderate depression (14-20) anxiety (10-14) stress (19-25)		Severe depression (21-27) anxiety (15-19) stress (26-33)	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Depression	Pre SN	7	8.8	30	37.5	43	53.8	0	0.0
	Post SN	25	31.3	52	65.0	3	3.8	0	0.0
Anxiety	Pre SN	4	5.0	29	36.3	47	58.8	0	0.0
	Post SN	6	7.5	73	91.3	0	0.0	1	1.3
Stress	Pre- SN	10	12.5	65	81.3	5	6.3	0	0.0
	Post SN	65	81.3	15	18.8	0	0.0	0	0.0

Depression (row-wise %; Z=7.117; p<0.001), anxiety (row-wise %; Z=6.333; p<0.001), stress (row-wise %; Z=7.266; p<0.001), SN: surya namaskar.

The change in mean DASS score of study population after surya namaskar by means of paired 't' test (Table 3).

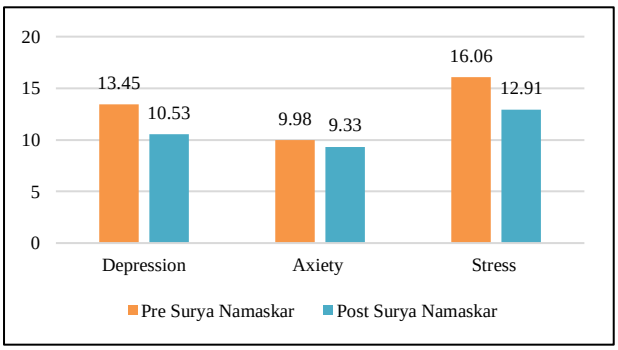

Figure 1: Comparison of pre and post surya namaskar DASS score.

Mean depression score of subjects before surya namaskar was 13.45±2.52 which after 6 months of training and practice of surya namaskar declined to 10.53±1.95. A decline of 2.93±1.81 (21.75%) in pre-intervention depression score was observed, which was found to be significant statistically. Pre-surya namaskar and post-surya namaskar mean anxiety scores were 9.98±1.67 and 9.33±1.56. Significant decline in anxiety score (0.65±1.47) in pre-intervention anxiety score was observed. Percentage change in pre-intervention anxiety score was 6.62%, this change was found to be significant statistically. Mean stress score of subjects before Surya Namaskar was 16.06±1.49 while that after 6 months of training and practice of Surya Namaskar was 12.91±1.72. A decline of 3.15±1.96 (19.61%) of pre-intervention stress score was observed. This change was found to be statistically significant (Figure 1).

The qualitative change in depression, anxiety and stress after intervention of surya namaskar by using Wilcoxon signed rank test (Table 4).

This shows before surya namaskar training, only 8.8% did not have depression (score 0-9), 37.5% had mild depression (score 10-13) and majority i.e. 53.8% had moderate depression score (score 14-19). After 6 months of training and practice of surya namaskar, 31.3% subjects did not have depression, 65% had mild depression and only 3.8% had moderate level of depression. Statistically significant qualitative change in pre-intervention severity of depression was observed (Figure 2).

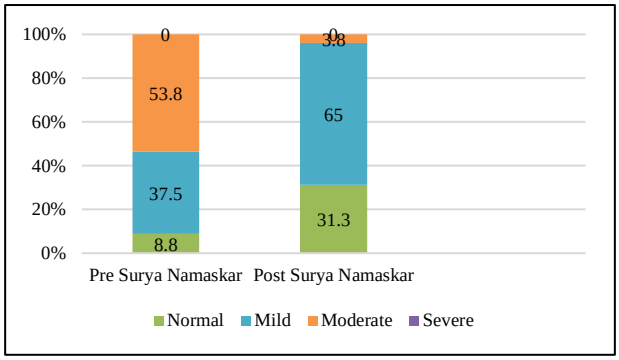

Figure 2: Qualitative change in depression after surya namaskar.

Before surya namaskar majority of subjects had moderate level of anxiety i.e. score 10-14 (58.8%), 36.3% had mild level of anxiety i.e. score 8-9 and 5.0% had no anxiety i.e. score 0-7. After 6 months of surya namaskar training and practice, only 1 (1.3%) subject had severe anxiety i.e. score 15-19. A vast majority of subjects had mild level of anxiety and 7.5% had no anxiety. Qualitative change in anxiety levels of participants after surya namaskar intervention was found to be significant statistically (Figure 3).

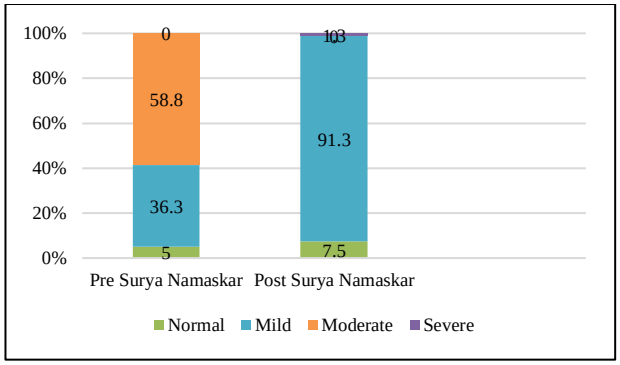

Figure 3: Qualitative change in anxiety after surya namaskar.

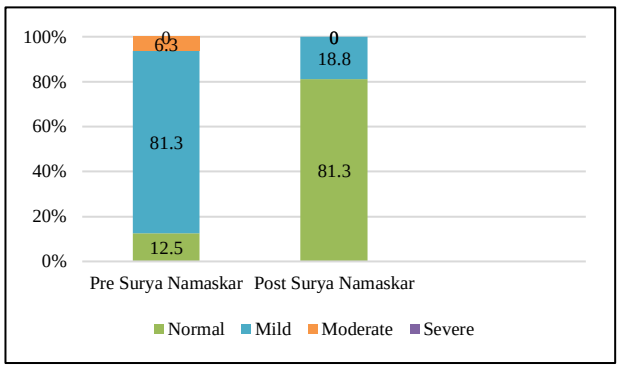

Figure 4: Qualitative change in stress after surya namaskar.

Before surya namaskar, 87.6% participants had mild-moderate level (81.3% mild score 15-18; 6.3% moderate score 19-25) of stress rest 12.5% had normal stress level i.e. score 0-14. After intervention 81.3% had normal stress levels, rest 18.8% had mild level of stress. Qualitative change in stress levels after intervention of surya namaskar was found to be significant statistically (Figure 4).

Table 5: Correlation of serotonin levels with anthropometric parameters.

Anthropometric Parameters	Correlation Coefficient (r)		Level of Correlation		P value		Level of significance	
	Pre SN	Post SN	Pre SN	Post SN	Pre SN	Post SN	Pre SN	Post SN
Weight	0.035	0.152	Poor	Poor	0.761	0.177	NS	NS
Height	0.070	0.142	Poor	Poor	0.538	0.208	NS	NS
BMI	-0.038	0.051	Poor	Poor	0.740	0.655	NS	NS
Waist circumference	0.048	0.170	Poor	Poor	0.671	0.133	NS	NS
Hip circumference	0.123	0.333	Poor	Mild	0.275	0.003	NS	Significant
WHR	-0.054	-0.091	Poor	Poor	0.632	0.420	NS	NS
Sag. abd diameter	0.143	0.027	Poor	Poor	0.206	0.809	NS	NS

The correlation of serotonin levels with anthropometric parameters pre surya namaskar and post surya namaskar (Table 5). Pre-intervention serotonin level did not show any significant correlation with pre-intervention anthropometric measurements. Post-surya namaskar serotonin level did not show any significant correlation with post-intervention anthropometric measurements except with hip circumference. Mild correlation between

post-intervention serotonin levels and hip-circumference was observed.

DISCUSSION

In recent years, there has been a renewed interest in traditional lifestyles and rituals with regard to their health. The health benefits of various physical exercises during worship and as part of religious practice have been enumerated in recent years using scientific methods. Among these, yoga is probably the most extensively studied set of physical exercises for their health benefit.[25-27] However, in addition to yoga, the benefits of Islamic prayer (salah/namaz), Buddhist meditation, and African ngoma healing practices have also been studied for their health benefits, particularly in relation to mental health.[28-31] Apart from this, it has also been reported to affect physical well-being by promoting obesity reduction and cardiorespiratory fitness.[32] Considering the reported benefits of surya namaskar, the present study was undertaken to investigate the effects of surya namaskar on anthropometric, biochemical and psychological parameters in an apparently healthy population of young adults.

For this purpose, a prospective intervention study was conducted in which a total of 80 apparently healthy young adults (aged 21 to 38 years; mean age, 28.89±3.87 years; 53.8% men) were included in the study. Regarding the study design, although intervention studies with a before-after design, such as the one used in the present study, are considered the simplest and most economical study designs, in which the change in the parameter of interest is attributed to the intervention implemented, this change may be due to natural variations caused by seasonal or temporal changes or a change in the instrument used for measurement.[33] Thus, the lack of a comparison group without intervention was one of the limitations of the present study. Considering that the present study was conducted as a pilot study and was not intended to claim superiority of surya namaskar over other modalities, nor did it include diseased patients, this evaluation was conducted in the simplest form of an intervention study as a preliminary feasibility study.

The selection of the apparently healthy population was made because the efficacy of surya namaskar as a sole therapeutic modality for a particular health condition has not yet been established. In addition, the present study was a preliminary evaluation to explore the feasibility and potential benefits of surya namaskar, which would pave the way for subsequent studies in various health conditions of interest.

The evaluation of the efficacy of surya namaskar in terms of its benefits to the physical, physiological, biochemical, or psychological profile, which is still in its early stages, was generally conducted in an apparently healthy population of young adults.

In the present study, an average reduction in various anthropometric parameters, namely weight, waist circumference, BMI, sagittal abdominal diameter, and WHR was observed in the study population after the intervention. Increment in hip circumference was seen. For all anthropometric parameters, the observed change was also statistically significant. In a previous study of 87 obese women, Jakhotia et al also found a significant reduction in body weight and BMI after surya namaskar that was comparable to that of the circuit training and treadmill groups.[32] In the present study, although we did not have a comparison group, we found similar results. Shakeela and Sugumar also found a significant reduction in BMI of female college students after the Surya Namaskar intervention in their study.[34] In their study, there were two combinations of the surya namaskar intervention, one with walking and one without walking. Although they observed an additional BMI decrease in the group that was supplemented with walking, both groups showed a decrease in BMI compared to the control group. These results support the use of surya namaskar as an additional weight loss intervention. Another study also found a positive significant effect of surya namaskar on anthropometric parameters, especially weight and BMI.[35]

In the present study, we also observed a significant reduction in physiological/vital parameters of the study population (blood pressure and heart rate) after the intervention. The results of the study are consistent with the observations of Mody who also found an improvement in cardiorespiratory fitness and weight management with regular practice of surya namaskar.[24] A number of other researchers also confirmed the positive effects of surya namaskar on weight management, physical fitness, and cardiorespiratory fitness.[32] Surya namaskar is believed to increase gas exchange at the alveoli and improve cardiorespiratory efficiency.[36,37] Thus, the results of the present study support a physiological beneficial effect of surya namaskar on the vital signs studied.

In the present study, we also found a significant improvement in serotonin levels after the intervention. It has been previously shown that yoga practices produce some positive changes in neurotransmitter systems such as serotonin, dopamine, and norepinephrine, however, there is no concrete evidence in this regard.[38-40] The results of the present study support the fact that surya namaskar practice tends to significantly improve serotonin levels.

In the present study, a phenomenal and significant improvement in psychological well-being was observed. The decrease from 53.8% moderate depression pre-intervention to 3.8% post-intervention, from 58.8% moderate to severe anxiety pre-intervention to 1.3% post-intervention, and from 87.5% mild to moderate stress pre-intervention to 18.8% post-intervention demonstrate the successful role of surya namaskar on the psychological profile of the participants. The successful role of surya namaskar in reducing stress among high stress college students was also reported in a previous study by Godse et

al.[41] In another study, Suresh and Preethi found that among participants who practiced surya namaskar, 64% and 36% were with low and moderate stress, respectively, while among similar participants who did not practice surya namaskar, 72% and 16% were with moderate and high stress, respectively. The positive impact of the intervention surya namaskar on occupational stress was also documented by Varsha in her study involving 48 software professionals aged 30-50 years (mean age 38.34±7.62 years). Also in our study, some participants were professionals in the medical field who may have suffered from occupational/educational stress that affected their psychological well-being and was successfully reduced after the surya namaskar intervention. Other studies in different age groups have also shown a positive impact of the surya namaskar intervention on stress and psychological well-being.[37,42-44] The effects of surya namaskar on psychological well-being in terms of reducing depression, anxiety, and stress in the present study were similar to those reported in a previous study for hathayoga exercise.[45] Thus, it can be concluded that changes in serotonin levels may play a role in this phenomenal change in participants' psychological well-being.

As for the correlation of the change in serotonin level with various anthropometric, and psychological parameters, we could not derive any significant correlation. Most of the bivariate correlations were weak and poor and not statistically significant. This suggests that while serotonin may be hypothesized to be a factor in improving psychological well-being, as has been suggested in previous studies, whether these elevated levels in serum alone fully reflect the picture.[46] It is likely that serum serotonin levels may not correlate well with the availability of serum serotonin levels in the brain. As for the effects of serum serotonin levels on other anthropometric parameters, there is little literature to support such a role, especially in an apparently healthy young adult population. In the present study, we were unable to investigate the reason for the lack of correlation between elevated serotonin levels and other parameters of interest, particularly those related to psychological well-being. However, we hypothesize that the change in serotonin levels induced by surya namaskar has a cardinal benefit rather than a marginal benefit; further mathematical models to assess this cardinal benefit need to be explored. Nonetheless, we note as a result a significant improvement in all parameters studied, but this improvement did not correlate with changes in serotonin levels.

Thus, the results of the present study provided some insight into the utility of surya namaskar in inducing positive changes in anthropometric, biochemical, and psychological parameters.

There are some limitations of study. There was no control group in the study. This study would be more impact full with addition of control group. Inclusion of a greater number of participants with wide variation in age, weight, BMI would make the study more impactful. Calorie tracking of participants while studying of impact of surya namaskar on anthropometric parameters would have created a more impactful result and helped us excluding bias of altered behaviour during study time. Inclusion of subjects with different mental and physical health problems could be done for more detailed analysis.

CONCLUSION

Surya namaskar leads to a significant positive change in anthropometric, physiological, biochemical and psychological parameters. The changes of weight (kg), waist circumference (cm), BMI (kg/m²), WHR were significantly decreased and hip circumference (cm) and serotonin levels was significantly increased after surya namaskar. Moderate depression, severe anxiety and moderate stress were also significantly reduced after surya namaskar.

The present study was conducted on an apparently healthy population, so there was no phenomenal change in the already normalised parameters studied. The clinical application of surya namaskar for the treatment of obesity and psychological stress is recommended.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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