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## Role of *sudarshan kriya* and *pranayam* on lipid profile and blood cell parameters during exam stress: A randomized controlled trial

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### Abstract

[Go to:](#)

### Background:

[Go to:](#)

Yoga is a science practiced in India over thousands of years. It produces constituent physiological changes and has sound scientific basis.

### Aim:

[Go to:](#)

Since exam stress modifies lipid profile and hematological parameters, we conducted an investigation on the effect of *sudarshan kriya* (SK and P) program on these parameters.

### Materials and Methods:

[Go to:](#)

Blood samples of 43 engineering students were collected at four intervals namely baseline (BL), exam stress (ES), three and six weeks practice of SK and P during exam stress. Lipid profile and hematological parameters were measured at all four intervals.

### Results:

[Go to:](#)

ES elevated total cholesterol (TC), triglycerides (TGL) and very low density lipoprotein (VLDL) levels. Hematological parameters affected by ES included neutrophil, lymphocytes, platelet count, packed cell volume (PCV) and mean cell volume (MCV). Three and six weeks practice of SK and P reduced the elevated lipid profile, hematological parameters and improved lymphocyte levels.

### Conclusion:

[Go to:](#)

Our study indicates that SK and P practice has the potential to overcome ES by improving lipid profile and hematological parameters.

**Keywords:** Exam stress, hematological parameters, lipid profile, *sudarshan kriya*, yoga

## INTRODUCTION

[Go to:](#)

Stress is one of the main reasons for the development of various pathological conditions. These include psychological disorders such as depression and anxiety[1,2] and medical disorders, including coronary heart diseases, hypertension and diabetes[3] Physiological studies have shown that stress from any source can influence the endocrine, hemopoietic and immune system. Cytokines and cortisol seem to play an important role in the communication of these systems.[4]

The stress response consists of activation of sympathetic nervous system (SNS) and hypothalamo-pituitary-adrenal (HPA) axis.[5] The activation of the SNS results in non specific physiological changes including release of catecholamines which increases heart rate, blood pressure and cardiac volume.[6]

Various studies have been conducted to examine lipids and lipoproteins under different stressors. Some of those have shown increase[7,8] and others detected decrease[9] of blood lipids and lipoproteins.

Studies on the effect of episodic stress such as final examinations on lipid concentration have been reviewed.[10,11] Exam stress can also cause some physiological changes. Qureshi *et al.*,[12] have found that exam stress in students alters certain blood cell parameters which includes neutrophils and platelets.

Higher levels of stress may have a negative impact on the students' learning ability. Excessive stress may result in mental and physical problems and may cause negative academic, emotional or health outcomes.[13]

If a method to reduce exam stress as well as enhance coping ability and academic performance exists, students would perform better. Hobson and Delunas[14] have performed a study to find out the efficacy of different techniques for reducing stress in business students. They have shown that relaxation therapies significantly reduce the stress level in students.

Mind body medicine (MBM) is an exciting field of complementary and alternative medicine (CAM). MBM combines the characteristics of ancient traditional healing system with the modern biomedical model to create an integrated approach to health care. *Sudarshan kriya* and *pranayam* (SK and P) is a rhythmic breathing technique which emphasizes breathing in three different rhythms. SK and P is preceded by *Ujjai Pranayam* and *Bhastrika*. SK and P has been found to be useful for relieving depression[15,16] and improving antioxidant defenses in the body.[17] EEG studies[18] revealed increased beta-activity during resting state (indicative of alertness) and increased alpha and beta-activity during the process of SK and P (indicative of relaxed alertness).

Although many stress reduction techniques are well known, there is lack of research about their usefulness in reducing exam stress in students which may help in better performance by the students.

Hence, the present study is aimed to find out the effect of SK and P in reducing exam stress in students by measuring the levels of lipid profile and blood cell parameters which are found to be altered during exam stress.

## MATERIALS AND METHODS

[Go to:](#)

### Participants

The subjects in this study included 43 undergraduate students (aged 18–23 years, males- 20, females-23) from SRM Engineering College, SRM University. The students volunteered themselves after an orientation session in the campus. The protocol for this study was approved by the Institutional Ethical committee. The participants gave informed consent after the study design was fully explained.

Subjects were excluded if they had a medical disease, they currently suffer from any infections, allergies or inflammatory responses, and they had ever been taking major psychotropic medications, smokers or alcoholics. Also subjects were excluded if they had abnormal baseline blood tests (lipid profile and blood cell parameters).

### Study design

The study included forty-three students and was randomized into two major groups.

Group I ( $n=21$ ) : Control group

Group II ( $n=22$ ) : Study group

The two groups were further subdivided as follows

Group Ia : Baseline (no exam) [BL]

Group Ib : Exam stress [ES]

Group Ic : Three weeks+exam stress

Group Id : Six weeks+exam stress

Group IIa : Baseline (no exam) [BL]

Group IIb : Exam stress [ES]

Group IIc : SK and P practice (three weeks)+exam stress

Group IId : SK and P practice (six weeks)+exam stress

There were three drop outs, two from control group and one from study group because of abnormal baseline parameters. The remaining 40 students (19 in control and 21 in study group) participated in the study.

Baseline data was measured few days after beginning of the second academic year. The students did not have any exams or any academic burden during baseline investigations. There was approximately two week time between baseline and exam stress. After collecting the baseline and exam stress blood samples, the students of study group participated in the yes plus course which is a six day course and students were asked to practice these exercises daily for six weeks. Follow up sessions were conducted every week. Blood was collected after three weeks and after six weeks from both the groups. Care was taken so that exams took place at the end of three and six weeks in order to study the true effect of SK and P practice on exam stress.

### Description of intervention

Yes plus course of Art of Living Foundation is a one week course. The instructors in SK and P were trained by International Art of Living foundation. *Sudarshan kriya* is derived from the Yogic Sciences of Breath from Vedic texts. It includes gentle stretches (asanas), specific breathing exercises, meditation and thoughts which create positive thinking.

The Asanas include Neck roll, Shoulder rotation, Peacock asana, Swing, Half moon stretch, Breath of joy, Cat Pose, Butterfly pose, Cradle pose, Wind-Relieving Pose, Boat pose, Serpent Posture, Locust Posture, Mountain Posture and Yoga Nidra.

The breathing techniques that are part of SK and P are:

- Three stage *Pranayam* with Ujjayi or “Victory Breath”

**First stage** In this stage, hands are kept on the pelvic bone and participants are trained to breath in Ujjai for a definite period. Then they are asked to hold the breath for a definite period and then asked to breath out in Ujjai for a definite period.

**Second stage** In this stage hands are kept on chest area and breathing in and out in Ujjai and holding the breath are done in the same fashion as first stage.

**Third stage** In this stage hands are kept on the back of the shoulder and breathing is done in the same fashion as first stage.

- Three sets of Bhastrika or “Bellow's Breath”

*Bhastrika Pranayam* involves hand movements up and down and are coordinated with fast breath in and out through the nose. This is followed by OM chanting 3 times followed by *sudarshan kriya*.

- *Sudarshan kriya* or the healing breath technique.

*Sudarshan kriya* involves rhythmic breathing where three cycles of breath namely slow, medium and fast breath are followed cyclically. The entire *kriya* involves multiple rounds with each round having long, medium and short inhalation and exhalation with varying rhythms and intensities. The home SK and P

instruction was given on the last day of the workshop. It starts with 20 long and slow in and out breaths, 40 medium length breaths and 40 short and fast ones. This 20-40-40 is done three times and lasts a total of 7-9 min. After practicing SK and P, the practitioners observed silence keeping his/her body immobile for 1 min and pay attention to their body and then finish with five long, slow so-hums after which the practitioners lies down in supine position for deep meditation for few minutes.

Meditations used in this are Guided Meditation and includes Panchakosha meditation and Space meditation.

## Methodology

Fasting blood sample (5 ml) was collected between 8.00 and 9.30 am by vein puncture. Serum was separated and assayed for lipid profiles namely total cholesterol (TC), triglycerides (TGL), high density lipoproteins (HDL), low density lipoproteins (LDL), very low density lipoproteins (VLDL) using commercial kit from Biosytem in a semi auto analyzer.

Hematological parameters were measured in a Sysmex automated hematology analyzer (XT-2000i/XT-1800i). Both the measurements were performed within 1 h of sample collection.

## Statistical analysis

Values are mean±SD in each group and significance of difference between mean values were determined by one-way analysis of variance (ANOVA) followed by Duncan test for multiple comparison.

## RESULTS

[Go to:](#)

[Table 1](#) shows the effect of *sudarshan kriya* and *pranayam* on lipid profile during baseline (BL), exam stress (ES) and after three weeks and six weeks practice in both control and study groups.

In both the groups, the level of cholesterol, TGL, VLDL were found to be increased significantly ( $P<0.01$ ,  $P<0.001$ ,  $P<0.001$  respectively) during ES when compared with BL.

In the study group, both three weeks and six weeks practice of SK and P+ES decreased the level of cholesterol significantly at the level of  $P<0.05$  when compared with ES. But in control group, there was no significant change in cholesterol level after three and six weeks. A significant decrease ( $P<0.01$ ,  $P<0.01$ ) in cholesterol level was observed in three and six weeks samples from study group when compared with three and six weeks of control group.

In the study group, there was a significant decrease in TGL levels after three weeks ( $P<0.01$ ) and six weeks ( $P<0.001$ ) of practice of SK and P+ES. There was no significant change in TGL level after three and six weeks in control group. Three and six weeks samples from the study group showed significant decrease ( $P<0.01$ ,  $P<0.01$ ) in TGL level when compared with three and six weeks samples respectively from control group.

VLDL level, which was also found to be increased during ES, decreased significantly after three weeks ( $P<0.05$ ) and six weeks ( $P<0.01$ ) of SK and P practice +ES in study group. Whereas control group did not show any decrease in VLDL level after three and six weeks. Comparison was also made between three and six weeks samples between the 2 groups. Three and six weeks samples from study group showed significant decrease ( $P<0.01$ ,  $P<0.01$ ) in VLDL level when compared with three and six weeks samples from control group.

LDL and HDL levels were found to be unaltered during ES as well as after three and six weeks in any of the groups.

Tables [2a](#) and [2b](#) depicts the mean value for hematological parameters during the four study intervals in control and study groups respectively.

Of all the hematological parameters assessed, neutrophil, platelet counts, PCV and MCV were found to be increased significantly ( $P<0.001$ ,  $P<0.01$ ,  $P<0.05$ ,  $P<0.05$  respectively) during ES when compared to BL in both the groups.

A decrease in neutrophils and platelet counts was observed in three weeks ( $P<0.01$  and  $P<0.05$ ) and six weeks ( $P<0.001$  and  $P<0.01$ ) practice of SK and P+ES respectively. Lymphocyte count was found to be decreased significantly ( $P<0.01$ ) during ES and was found to be elevated after three weeks ( $P<0.01$ ) and six weeks ( $P<0.01$ ) of practice of SK and P+ES. Whereas control group did not show any decrease in any of the parameters after three and six weeks.

Comparison was also made between three and six weeks of study group with three and six weeks of control group. In the study group, level of neutrophil was found to be decreased significantly in three weeks ( $P<0.05$ ) and six weeks ( $P<0.05$ ) after practicing SK and P when compared with three and six weeks practicing of control group. Similarly in the study group, level of lymphocytes was found to be increased significantly in three weeks ( $P<0.01$ ) and six weeks ( $P<0.01$ ) when compared with three and six weeks of control group. Level of platelet count was found to be decreased significantly in three weeks ( $P<0.05$ ) and six weeks ( $P<0.05$ ) of study group when compared with three and six weeks of control group.

Practice of SK and P did not bring any significant changes to the levels of PCV and MCV. MCH was found to be decreased after six weeks of practice at the level of  $P<0.05$  when compared with exam stress even though there was no significant change of MCH found between ES and BL.

## DISCUSSION

[Go to:](#)

Yoga is considered to be one of the most important effective and valuable ancient Indian systems to overcome various physical and psychological problems. Studies on yoga claim prolonged existence[19,20] and has therapeutic[21,22] and rehabilitation effects.[23] Yoga includes breathing exercises, physical exercises (Asanas) and meditation. One such practice is *Sudarshan kriya* and *Pranayam* (SK and P) which includes asanas, meditation and special breathing technique.

Examination stress has been considered as a good model of naturally occurring psychological stress. It can be very potent stressors especially when the exam is perceived as important to the individual's future career objective. Excessive stress may result in mental and physical problems and may diminish a student's sense of worth and might affect his/her academic achievement.[24,25]

In the present study, total cholesterol (TC), triglycerides (TGL) and VLDL were found to be increased during exam stress. The elevated TC, TGL and VLDL were decreased after three and six weeks practice of SK and P. HDL and LDL were observed to be unaffected during exam stress. Dietary intervention affects lipid profile.[26] In our study, even though the students had similar dietary habit and level of physical activity, students had significantly higher serum cholesterol, TGL and VLDL during ES which was decreased appreciably after SK and P practice.

These findings are consistent with previous reports on the effects of exam stress on plasma lipid concentration.[27] However, exam stress in engineering students has not been scientifically reported so far. This is the first study of its kind to document effect of yoga and exam stress on lipid profile and hematological parameters in engineering students. Since SRM University is a multi stream University this task was possible for our group.

Activation of sympathetic nervous system during psychological stress increases the production of serum lipids and lipoproteins by altering serum lipid metabolic processes.[28] Catecholamines induce lipolysis and release free fatty acids into the circulation; free fatty acids in turn serve as substrate for the re synthesis of triglycerides and subsequently VLDL production by the liver.[29]

Another reason for the increase in serum lipids during stress was given by Patterson *et al.*,[30] according to which psychological stress can cause acute intravascular hemoconcentration through a decrease in plasma volume, which leads to an increase in the concentration of blood cell, plasma proteins and circulating lipoproteins. Several studies have suggested that hemoconcentration accounts for rise in total and HDL cholesterol during experimental stressors.[8,30,31] However, certain studies have found that adjusting for hemoconcentration did not eliminate increase in lipid concentration.[30,32]

In our study after three weeks of practice of SK and P, there was a significant reduction in the level of TC, TGL and VLDL which were found to be elevated during exam stress. Further reduction in the levels was

seen after six weeks of practice of SK and P. Better ability to overcome stress can be cited as a possible mechanism for improvement in lipid profile.[33]

Recently Sayyed *et al.*,[34] have found significant improvement in lipid profile parameters after SK and P practice. The improvement in the lipid profile could be due to increased hepatic lipase and lipoprotein lipase in cellular level, which affects the metabolism of TGL by adipose tissue.[35]

In our study, certain hematological parameters like neutrophils, platelet counts, packed cell volume (PCV) and mean cell volume (MCV) were found to be increased and lymphocyte count was found to be decreased during exam stress in students. No significant changes were seen in hemoglobin, red blood cells and other parameters.

Our result is consistent with previous report of Qureshi *et al.*,[12] indicating an increase in neutrophils, platelet count and decrease in lymphocytes. But they have reported that PCV and MCV remain unaltered during exam stress. Maes *et al.*,[36] studied the influence of academic examination stress on hematological measurements and found that exam stress significantly increased hematocrit, HB, MCV, MCH and MCHC.

It has been suggested that stress-induced pro inflammatory cytokine production may stimulate the proliferation of hematopoietic cells.[37] Increase in neutrophils, platelets, PCV, MCV following stressor may be explained by hemoconcentration, which is caused by shifts of fluid from the intravascular to extra vascular spaces concentrating non diffusible blood constituents.[38,39]

Jern *et al.*,[40] found that there was a significant increase of platelet during psychological arousal. The increase in platelet concentration during psychological arousal is also in accordance with what has been observed in response to other stressors i.e. physical exercises, adrenaline infusion.[41,42] The mobilization of platelets is probably the effect of an instant alpha adrenergically mediated release of platelets from the exchangeable splenic platelet pool.[43] This platelet activation may be a mechanism linking psychosocial stress with increased coronary risk, and may also play a role in the emotional triggering of acute coronary syndromes in patients with advanced coronary disease.[44]

After practicing SK and P for three weeks, the level of neutrophils and platelets were decreased significantly. Further reduction in the level was seen after six weeks of practice. SK and P were not found to have any effect on PCV and MCV. Lymphocyte count was increased after SK and P practice indicating that practice of SK and P improves immunity. Previous reports suggest that total T cells and its T helper subsets were significantly higher in SK and P practitioners.[45] Practice of SK and P cause relaxation response. This relaxation might have stopped the alpha adrenergically mediated platelet release.

However, further extensive and long-term studies are required to prove these findings and understand the basic mechanisms involved. Thus, practice of SK and P seems to be beneficial on lipid profile and hematological parameters during ES in engineering students.

## Footnotes

[Go to:](#)

**Source of Support:** Nil

**Conflict of Interest:** None declared.

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[Go to:](#)

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## Figures and Tables

[Go to:](#)

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**Table 1**

Levels of lipid profile in control and *sudarshan kriya* and *pranayam* practice group (all values are denoted as mean±SD)

Parameters	Control group (Group I)				Study group (Group II)			
	Group Ia	Group Ib	Group Ic	Group Id	Before SK and P practice		After SK and P practice	
					Group IIa	Group IIb	Group IIc	Group IId
Cholesterol (mg/dl)	143 ± 17.3	169.1 ± 16.6 <sup>A1**</sup>	170.4 ± 13.4	168.2 ± 18.2	147.1 ± 16.1	168.3 ± 14.4 <sup>A2**</sup>	152.9 ± 14.9 <sup>A3*</sup> B1**	146.7 ± 23.6 <sup>A4*</sup> B2**
HDL (mg/dl)	40.7 ± 6.8	44.9 ± 2.8	45.7 ± 2.3	45.4 ± 2.6	40.2 ± 7.9	43.3 ± 5.7	42.8 ± 5.4	42.5 ± 7.6
LDL (mg/dl)	97.4 ± 22.1	100.4 ± 28.3	98.2 ± 23.9	102.4 ± 12.4	96.5 ± 7.1	102.8 ± 15.6	95.1 ± 17.6	90.85 ± 27
TGL (mg/dl)	75.4 ± 22.5	106.1 ± 22.5 <sup>A1***</sup>	103.7 ± 16.1	102.4 ± 15.1	72 ± 7.1	101.3 ± 13.3 <sup>A2***</sup>	84.4 ± 14.4 <sup>A3**</sup> B1**	71.0 ± 11.4 <sup>A4***</sup> B2**
VLDL (mg/dl)	15.0 ± 4.2	21.1 ± 5.9 <sup>A1***</sup>	19.3 ± 4.96	21.2 ± 2.8	14.1 ± 1.2	22.6 ± 4.7 <sup>A2***</sup>	16.5 ± 4.2 <sup>A3*</sup> B1**	14.3 ± 4.2 <sup>A4**</sup> B2**

Group I - Control group, Group II - Study group, Group Ia - Baseline, Group IIa - Baseline, Group Ib - Exam stress, Group IIb - Exam stress, Group Ic - Three weeks +ES, Group IIc - SK and P practice (three weeks) +ES, Group Id - Six weeks +ES, Group IId - SK and P practice (six weeks) +ES, SK and P - *Sudarshan kriya* and *pranayam*, HDL - High density lipoproteins, LDL - Low density lipoproteins, VLDL - Very low density lipoproteins, TGL - Triglycerides, A - comparison within the group, A1 - Comparison between group Ia and Ib, A2 - Comparison between group IIa and group IIb, A3 - Comparison between group IIb and group IIc, A4 - Comparison between group IIb and IId, B - Comparison between groups, B1 - Comparison between group Ic and group IIc, B2 - Comparison between group Id and group IId, \*\*\*P<0.001, \*\*P<0.01, \*P<0.05

**Table 2a**

Levels of hematological parameters in control group (Group I) (all values are denoted as mean±SD)

Parameters	Group Ia	Group Ib	Group Ic	Group Id
Hb (g%)				
Male	13.2 ± 2.3	13.4 ± 1.3	13.25 ± 1.9	13.21 ± 1.2
Female	12.4 ± 3.6	12.36 ± 2.3	12.4 ± 2.5	12.0 ± 1.3
T.WBC (m/cumm)	7885.7 ± 909.99	7371.4 ± 888.3	7700 ± 734.8	7828 ± 552.5
Neutrophils (%)	51.4 ± 11.8	64.9 ± 12.2 <sup>A1***</sup>	66.6 ± 7.1	62.32 ± 5.4
Eosinophils (%)	3.3 ± 1.1	3.8 ± 1.6	3.2 ± 1.6	2.8 ± 1.3
Lymphocytes (%)	35.1 ± 2.7	21.4 ± 11.6	24.0 ± 9.3	22.8 ± 9.02
T.RBC milli/cumm				
Male	5.36 ± 0.92	5.42 ± 0.66	5.40 ± 0.63	5.41 ± 0.74
Female	4.42 ± 0.83	4.44 ± 0.63	4.32 ± 0.93	4.44 ± 0.65
Platelet count (laks/cumm)	2.12 ± 0.17	2.42 ± 0.39 <sup>A1**</sup>	2.44 ± 0.52	2.33 ± 0.14
PCV (%)	34.3 ± 2.2	43.3 ± 4.95 <sup>A1*</sup>	41 ± 10.2	40.3 ± 6.1
MCV (Femto litre)	78.3 ± 4.6	86.86 ± 3.3 <sup>A1*</sup>	85.8 ± 3.8	84.3 ± 4.1
MCH (pg/cell)	25 ± 4	31.3 ± 3.5	30.2 ± 2.77	29.5 ± 3.44
MCHC (%)	33.4 ± 2.8	35.4 ± 3.04	34.0 ± 2.35	32.5 ± 2.2

A - Comparison within the group, A1 - Comparison between group Ia and Ib, \*\*\*P<0.001, \*\*P<0.01, \*P<0.05, Hb - Hemoglobin, T.WBC - Total white blood cells, T.RBC - Total red blood cells, PCV - Packed cell volume, MCV - Mean corpuscular volume, MCH - Mean corpuscular hemoglobin, MCHC - Mean corpuscular hemoglobin concentration

**Table 2b**

Levels of hematological parameters in study group (Group II) (all values are denoted as mean MSD)

Parameters	Before SK and P practice		After SK and P practice	
	Group II a	Group IIb	Group IIc	Group IId
Hb (g%)				
Male	13.9 ± 1.6	14.2 ± 1.35	14.0 ± 1.52	14.1 ± 1.21
Female	12.8 ± 2.1	13.1 ± 1.43	12.9 ± 1.6	12.9 ± 1.3
T.WBC (m/cumm)	7700 ± 15.5	7800.5 ± 14.4	7600.9 ± 10.7	8000.1 ± 13.3
Neutrophils (%)	52.6 ± 5.7	71.3 ± 8.51 <sup>A2***</sup>	57.8 ± 7.5 <sup>A3** B1*</sup>	51.5 ± 5.6 <sup>A4**** B2*</sup>
Eosinophils %	4.4 ± 1.6	3.5 ± 2.1	4.2 ± 1.1	3.5 ± 1.01
Lymphocytes %	37.9 ± 9.1	29.4 ± 3.8 <sup>A2**</sup>	36.9 ± 7.3 <sup>A3** B1**</sup>	39.0 ± 7.4 <sup>A4*** B2**</sup>
T.RBC milli/cumm				
Male	5.36 ± 0.92	5.5 ± 0.58	5.44 ± 0.63	5.42 ± 0.68
Female	4.42 ± 0.83	4.4 ± 0.86	4.35 ± 0.75	4.57 ± 0.74
Platelet count lakhs/cu mm	2.06 ± 0.51	2.39 ± 0.45 <sup>A2**</sup>	1.96 ± 0.42 <sup>A3* B1*</sup>	1.94 ± 0.46 <sup>A4*** B2*</sup>
PCV (%)	33.3 ± 5.1	40.4 ± 6.1 <sup>A2*</sup>	38.4 ± 3.5	39.6 ± 4.8
MCV (femtoliter)	83.9 ± 6.4	88.9 ± 4.8 <sup>A2*</sup>	84.7 ± 10.5	84.5 ± 7.2
MCH (pg/cell)	28.7 ± 4.3	32.1 ± 5.9	28.4 ± 5.7	24.5 ± 3.2 <sup>A4*</sup>
MCHC (%)	33.1 ± 5.6	32.6 ± 6.0	32.1 ± 4.7	30.3 ± 4.3

A - Comparison within the group, A2 - Comparison between group IIa and group IIb, A3 - Comparison between group IIb and group IIc, A4 - Comparison between group IIb and IId, B - Comparison between groups, B1 - Comparison between group IIc and group IId, B2 - Comparison between group IId and group IId, \*\*\*P<0.001, \*\*P<0.01, \*P<0.05, SK and P - Sudarshan kriya and Pranayam, Hb - Hemoglobin, T.WBC - Total white blood cells, T.RBC - Total red blood cells, PCV - Packed cell volume, MCV - Mean corpuscular volume, MCH - Mean corpuscular hemoglobin, MCHC - Mean corpuscular hemoglobin concentration

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