

Hematological and biochemical modulation in regular yoga practitioners.

Gabriel A. Carranque^{a*}, Enrique F. Maldonado^b, Francisca M. Vera^b, Juan M. Manzanque^b, Maria J. Blanca^b, Gema Soriano^c, Miguel Morell^{c†}

^aDepartment of Surgery. School of Medicine. Malaga University. Teatinos Campus. 29010. Malaga. Spain

^bDepartment of Psychobiology & Methodology. Psychology Faculty Malaga University, Teatinos Campus, 29010. Malaga. Spain

^cDepartment of Biochemistry. School of Medicine. Malaga University. Teatinos Campus, 29010. Malaga. Spain

Abstract

Yoga is a physical and mental discipline that forms part of Ayurvedic medicine, a comprehensive and ancient holistic health system. Given the limited information available on the hematological and biochemical changes associated with the extended practice of yoga, the purpose of the present study was to examine the effects of long-term yoga practice (more than three years) on blood parameters. Twenty-six healthy volunteers of whom sixteen were advanced practitioners of yoga took part in the study. The remaining ten participants were not practitioners and constituted the control group. Blood samples were taken to determine the following hematological parameters: erythrocytes, hematocrit, hemoglobin, platelets and erythrocyte sedimentation rate; and biochemical parameters: renal and hepatic profile, glucose, uric acid, total protein and albumin. The Mann-Whitney U test was performed to ascertain the statistical analysis. The experimental group showed higher hemoglobin levels ($p>0.01$) and erythrocyte sedimentation rate ($p>0.01$) and lower albumin levels ($p>0.05$). The regular practice of yoga brings about changes in basic hematological parameters. New clinical trials with a wider sample of subjects will be needed in order to recommend the use of yoga as a complementary therapy in those cases where the above-mentioned parameters are altered.

Key words: *Yoga, hemoglobin, erythrocyte sedimentation rate, albumin, mind/body medicine*

Accepted January 31 2012

Introduction

Yoga, a system of mental and physical exercise techniques aimed at achieving a state of well-being in human beings, originated some 6000 years ago in India and is one of the elements of Ayurvedic medicine (the Science of Life). While there are many different systems of yoga practice, all essentially include breathing exercises, physical postures and meditation. Traditional yoga is a philosophy for living and thus is associated with a series of behavioural modifications that contribute to a healthy life-style.

Today yoga is included in mind/body strategies[1] designed to promote good health that include relaxation techniques, hypnosis, visualization, feedback, Qigong [2-3], Tai Chi, meditation, autogenics, cognitive behavioural therapy, group therapy and spirituality. All these strategies are based on research into the connections between the nervous, immune and endocrine systems, all of which make up the basis of psychoneuroimmunology [4-6], the essence of mind/body strategies, efficacious in many

illnesses and greatly sought after by the general public [7-11].

The practice of yoga has proved useful both for the healthy and for the sick. In the former, higher scores were observed in variables such as the feeling of well-being, energy and fatigue evaluated in the quality of life questionnaire SF-36 [12-13] and in subjective sleep quality assessed by the Pittsburgh Sleep Quality index [14]. Better spirometry results (FEV1 and PEFr) were also obtained when compared with those seen in athletes [15]. A group of carers of the elderly also perceived a better state of general health [16].

In addition, recent research has confirmed the therapeutic effect on some diseases. Women subject to psychological stress found significant improvement of their symptoms after a three-month yoga program [17]. In anxiety disorders, at least two comparative studies of yoga and meditation techniques (mindfulness) revealed the same effectiveness for both procedures [18-19]. The increase in thalamic GABA levels observed after yoga practice

would explain the improvement in anxiety disorders, depression and multiple sclerosis where lower GABA levels were found [20]. In diabetic patients a sustained drop in glucose levels was achieved, both after fasting and after eating and an increase in the number of insulin receptors associated with decreased resistance was confirmed [21]. Yoga also acts as an essential variable in the prevention of cardiovascular disease [22]. Clinical practice guidelines for chronic back pain recommend it for its analgesic effect [23-24]. In tumoral processes, yoga contributes to an improved quality of life by lowering stress symptoms through the reduction of cortisol and Th-1 proinflammatory cytokines levels [25]. In disorders associated with menopause, positive feelings and self-esteem have increased and led to improving the quality of life [26]. It has been observed that a three-month practice of yoga for patients suffering from chronic renal insufficiency [27], undergoing haemodialysis, raises the red blood cell count by 11%, the hematocrit by 13% and lowers pain by 37% tiredness by 55%, urea by 29% and creatinine by 14% . In addition, as with other mind-body strategies [28], yoga is an effective technique for reducing stress and consequently can bring about clinical improvement in those processes where biopsychosocial stressors of special intensity are involved (cancer, bronchial asthma, etc.).

With regard to biochemical parameters, we have assessed the effects of yoga on the metabolic syndrome [29], on the lipid [30] and renal profiles [31] and have observed a certain modulating effect. However, changes in nutritional indicators, such as albumin, after prolonged yoga practice have yet to be studied in depth.

Given the limited information available on the hematological and biochemical changes associated with the extended practice of yoga, in this pilot study we assess the influence that prolonged practice (more than three years) has on the above-mentioned blood parameters.

Materials and Methods

Participants

Twenty-six healthy subjects (7 male, 19 female) aged between 30 and 50 took part in this study. The difficulty encountered in the selection of the sample, given the very nature of the study, determined that the age range of participants needed to be similar in both groups (control and experimental) to preclude its influence on the results obtained.

The experimental group consisted of 16 long-term yoga practitioners (12 female and 4 male), while the control group was made up of 10 ordinary subjects (7 female and 3 male). Male subjects constituted 30% of the control group and 25% of the experimental group. The percentage

of female subjects in the control group was 70% and in the experimental group, it was 75%. Thus, the gender split was not more than 5%.

Experimental subjects were recruited from several yoga centers in Malaga province. Control subjects were selected from a group of healthy individuals with no disease or suspicion of disease, programmed to go to hospital for a routine medical check-up. These subjects were, therefore, not in hospital owing to any pathology that could have compromised the representativity of the control sample. These individuals were of the same age and sex as the experimental group and followed a similar lifestyle but had no experience of yoga or similar techniques.

All subjects volunteered to participate in the study and gave written informed consent. A structured medical and psychological interview was carried out for their selection. Subjects were screened to exclude both those with any pathological conditions and those who had received pharmacological treatment in the three months prior to the experiment. Although all subjects were selected to be part of the control and experimental groups, in the days following their initial interview, they were at all times unaware that a selection process was underway. Only healthy subjects, with regular daily life habits, none of whom took any type of drugs or played sports regularly, were chosen to be part of the experimental or control groups. Female participants were all within the first ten days of their last menstrual cycle.

Table 1 summarizes information on sex, age, height and weight of all participants. As can be seen, none of these variables differed significantly between the control and the experimental groups. Subjects in the experimental and control groups were homogeneously distributed with respect to their occupation.

Yoga Program

The attendance register confirmed that the experimental subjects had been taking one-hour sessions, at least three times a week for the last three years at a traditional Sivananda yoga center. None of them had engaged in any other regular physical activity. The same instructor led all the training sessions and thus maintained the homogeneity of the physical and mental protocol. The procedure began with *Surya Namaskar* (Sun Salutation) and continued with a session of 12 *asanas* or physical exercises (fixed postures), each held for a certain length of time. *Pranayama* (yogic –abdomen, thorax, cervical– breathing), *Savasana* (physical, mental and spiritual relaxation) and *Dhyana* (meditation, mental tranquillity, inner peace) techniques accompany these exercises. Information obtained on the subject practitioner at an initial meeting with the yoga instructor ensured a homogeneous sample of experimental subjects that met the inclusion criteria for the trial.

Blood sampling

Between 8.30 and 9.30 a.m, the same nurse took blood samples from a forearm vein of all the participants, in identical basal repose and fasting (more than eight hours) conditions.

The clinical laboratories analyzed the following blood parameters: erythrocytes, hemoglobin, hematocrit, platelets, erythrocyte sedimentation rate (ESR), glucose, urea, creatinine, uric acid, bilirubin, GOT, GGT, GPT, alkaline phosphatase, total protein and albumin.

The following procedure was carried out on the blood samples:

- Analysis of hematological parameters (erythrocytes, hemoglobin, hematocrit, platelets and ESR): 4.5 ml of blood in an EDTA tube, erythrocytes and platelets analyzed by electronic impedance method; hemoglobin by spectrophotometer; hematocrit by numerical function of the mean corpuscular volume (MCV). A Horiba ABX Pentra DF-120 Analyzer was used. Lastly, the ESR was carried out by the Westergren method in which the sedimentation rate of the red blood cells is measured in mm/first hour.
- The biochemical analysis (glucose, urea, creatinine, uric acid, bilirubin, GOT, GGT, GPT, alkaline phosphatase, total proteins and albumin) was carried out according to the following protocol: 5 ml of blood in biochemical tube with a polyacrylamide gelatine separator and results were determined by spectrophotometer, using a Dade Behring Laboratory Dimension® analyzer.

Procedure

We used a quasi-experimental scheme. An initial meeting held with the yoga instructor obtained information on the practising subject and procured a homogenous sample of experimental subjects to fulfil the inclusion criteria of the study. All participants were interviewed at the start of the study to establish sociodemographic data, relevant medical information and specific practice protocol. Sub-

sequently they were given appointments for the blood tests.

The design of our study did not contemplate a base line condition and therefore the variables were measured only once. The choice of this experimental design was conditioned by the nature of the sample itself. The experimental group had of necessity, to be composed of yoga practitioners with prolonged experience and therefore this requirement rendered recording the initial measurements at the start unfeasible. This data had obviously been documented many years previously.

Taking into consideration the scarcity of information about the effects of prolonged and uninterrupted yoga practice, we consider that the use of this design in a first attempt to explore the changes associated with this practice is of major interest.

Statistical Analysis

The problems of normality and homoscedasticity of the study determined the application of the non-parametric Mann-Whitney "U" test to analyze the differences between the experimental and control groups of various dependent variables: erythrocytes, hemoglobin and hematocrit, ERS, glucose, urea, creatinine, uric acid, bilirubin, GOT, GPT, GGT, alkaline phosphatase, total proteins and albumin. These were done using the SPSS 13.0 data analysis package for Windows.

Results

Results are displayed on Table 2. We found significant changes between the Experimental and Control groups in ESR, hemoglobin and albumin.

Hemoglobin in yoga group showed higher values: 14.68 versus control group 9.45 ($p=0.038$). ESR values also increased in the yoga group: 15.39 versus control group of 8.45 ($p=0.008$). Albumin showed lower values in the yoga group: 9.97 versus control group with 17.56 ($p=0.006$). No significant changes were found in other variables.

Table 1. Mean \pm standard deviation, and range (in brackets), of sex, age, height and weight in the control and yoga groups (practice time), as well as statistic and p-value.

Variable	Experimental group (n=16)	Control group (n= 10)	Statistic	p-value
Sex	4 Men, 12 women	3 Men, 7 women	² 0.08	0.78
Age (year)	39.68 \pm 5.32 (30-51)	38.90 \pm 3.69 (31-43)	t= -0.50	0.68
Height (cm)	165.37 \pm 10.19 (149-190)	168.60 \pm 8.68 (157-180)	t= 0.83	0.41
Weight (kg)	61.62 \pm 12.65	64.60 \pm 13.11	t= 0.57	0.57
Months of yoga practice	47 \pm 3	--	--	--

Table 2. Mean, standard deviation (SD) in the control and yoga groups, as well as U-statistic

Parameters	Yoga Group	Control Group	U
Erythrocytes	12,04 ± 0,32	13,15 ± 0,29	63,5
Haemoglobin	14,68 ± 0,93	9,45 ± 1,16	39,5*
Hematocrit	12,18 ± 2,43	12,95 ± 11,19	65,5
Platelet	11,21 ± 4,87	14,30 ± 4,78	52
ESR	15,39 ± 4,17	8,45 ± 1,68	29,5**
Glucose	11,91 ± 9,9	16,05 ± 6,05	54,5
Urea	13,66 ± 8,06	13,25 ± 7,13	77,5
Creatinine	14,78 ± 0,163	11,45 ± 0,68	59,5
Uric Acid	13,63 ± 1,68	13,30 ± 0,29	78
Bilirubin	13,56 ± 0,29	13,40 ± 1,03	79
GOT	14,34 ± 3,3	12,15 ± 4,9	66,5
GPT	13,00 ± 8,1	14,30 ± 12,33	72
GGT	12,81 ± 7,76	14,60 ± 9,25	69
Alkaline Phosphatasa	14,19 ± 11,99	12,40 ± 20,43	69
Total Proteins	14,97 ± 0,26	11,15 ± 0,46	56,5
Albumin	9,97 ± 0,25	17,56 ± 0,32	23,5**

Discussion

The principal findings of this trial were the presence of higher levels of hemoglobin and erythrocyte sedimentation rate (ESR) and, when compared with the control group, lower albumin levels associated with prolonged yoga practice (longer than three years). To the best of our knowledge, these are the first results referring to these biological parameters in advanced practitioners.

The small size of the sample, together with the fact that the biochemical measurements were established only once could, to some degree, be considered a limitation to the study. However, this limitation must be understood as a consequence of the very nature and characteristics of this study. Specifically, one of the most significant difficulties we had to face in our research was the selection of long-term yoga practitioners who had at no time interrupted their practice and the selection of a control group who conformed to similar characteristics.

The first notable fact to emerge is that although regular yoga practice does generate a noticeable increase in hemoglobin, this does not imply there is an increase in the hematocrit values. This finding could partly explain the cardioprotectant effect of yoga practice which improves cell oxygenation by supplying red blood cells richer in hemoglobin without modifying the percentage of red blood cells in the total blood volume and consequently without elevating blood viscosity which is an important cardiovascular risk factor.

Certain authors have found that short-term yoga practice (40 days) in patients with type II diabetes [32] brings about a marked drop in levels of glycemia, and glycated

hemoglobin and a moderate rise of hemoglobin. In any event, we still do not know how the mechanics of the exercises function to bring about these modifications in blood parameters.

A further explanation of the cardioprotectant factor of yoga practice by the isolated increase in hemoglobin may be justified by the anti-stress effect produced by parasympathetic dominance [33-34].

Recent studies [35-37] on cardiovascular reactivity have confirmed that sympathetic stimulation conditioned by stress raises blood pressure and thus, elevates the osmotic pressure conditioning the flow of plasma from the vascular compartment to the interstitial compartment, increasing blood viscosity.

The increase in hemoglobin values after regular yoga practice might also add a new alternative therapeutic focus in those clinical situations where a deficit of this blood parameter is present.

The significant increase in the ESR in the group of yoga practitioners (within normal levels) does not indicate any inflammatory event but may play the role of modulator. ESR is a sign of unspecific inflammation. It is simple and cheap to obtain. It fluctuates easily, depending on the metabolic activity of the blood cells [38] and presents an important correlation with the serum levels of the different reagents in the acute phase [39-42]. An experimental study [43] indicates that emotional stress induced in rats causes a qualitative and quantitative change in the oxidation processes of the erythrocytes. Psychological stress activates the oxidation processes at membrane lipid level, modifying its permeability and disrupting the setting and release of oxygen. This suggests that the changes could be

the underlying mechanism in tissue hypoxia that plays an important role in the pathogenesis of cardiovascular diseases. Possibly the increase in the ESR in yoga practitioners represents one more consequence of yoga's antistress effect [44] reducing the oxidation process and release of free radicals at erythrocyte membrane level.

Measurement of ESR has been recently reappraised after a meta-analysis permitted calculation of ischemic heart disease risk among subjects according to hematocrit, plasmatic viscosity and ESR [45].

A higher ESR presents additional interesting data, the significance of which must be evaluated in future studies, given its value as a variable warning in inflammatory processes and a sign of ischemic heart disease risk [46-47].

The lower levels of albumin observed in advanced yoga practitioners have not been evaluated in any trial so far. Previous studies on the subject have shown inconclusive results albeit after a yoga practice period lasting only a few weeks. Other authors have found [48] that after only a short period of practice, albumin figures decreased while yet another study on the effects of a six-week yoga program showed no significant changes in albumin levels [49].

Advanced level yoga practice includes paying special attention to nutrition. An adequate diet is considered one of the pivotal points of its holistic system. The yoga diet is vegetarian and includes vegetables, cereals, fruit, and legumes as well as dairy products and honey. In any event, most of these foods contain enough protein so as not to affect the albumin levels in blood. It is possible that the nutritional habits of advanced practitioners of yoga may explain these biochemical changes but further specific nutritional research will be necessary to determine this fact.

Conclusions

In summary, the present work represents a first attempt to explore the impact of long-term yoga practice on specific hematological and biochemical parameters. The higher levels of hemoglobin without changes in hematocrit and increased ESR suggest a modulating effect that could have interesting clinical implications. Further research is needed to verify these preliminary results as well as to assess their possible application as complementary therapy.

Acknowledgments

We would like to thank M.D. Dr. Noela Rodríguez Losada of Laboratory IMABIS Foundation and the team

at the Hematology and Biochemistry laboratory at the University Hospital "Virgen de la Victoria" Malaga for their help and support in obtaining and analyzing blood samples. In addition, our thanks go to Professor Diana Mathieson, the teachers and students of Hatha Yoga Traditional Centre "Sivananda School" who collaborated in an exemplary manner in this study.

Author Disclosure Statement

The authors have no competing financial interests could harm the conductor presentation of this study.

References

1. Barnes PM, Powell-Griner E, McFann K, et al. Complementary and alternative medicine use among adults: United States, 2002. *CDC Advance Data*. 2004; 343, 1-19
2. Maldonado EF, Manzaneeque JM, Vera F, et al. Effects of a qigong meditation program on plasmatic lipid concentrations, cardiovascular function, and anxiety levels. *J. Psychophysiol*. 2003; 17 (1):49-49
3. Vera F, Manzaneeque JM, Maldonado EF, et al. Biochemical changes after a qigong program: Lipids, serum enzymes, urea, and creatinine in healthy subjects. *Med Sci Monitor*. 2007; 13 (12): 560-566
4. Ader R, Cohen N. Behaviourally conditioned immunosuppression. *Psychosom Med*. 1975; 37(4):333-340
5. Ader R, Cohen N. 1982. Behaviourally conditioned immunosuppression and murine systemic lupus erythematosus. *Science*. 1982; 215 (4539): 1534-1536
6. Adler R, Cohen N, Felten D. Psychoneuroimmunology: interactions between the nervous system and the immune system. *Lancet*. 1995; 345 (8942): 99-103
7. NCCAM. Whole Medical Systems: An Overview. Available from: <http://www.nccam.nih.gov/health/backgrounds/wholemed.htm> [on March 2, 2007].
8. Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States, 1990-1997: results of a follow-up national survey. *JAMA*. 1998; 280 (18): 1569-1575.
9. Astin JA, Shapiro SL, Eisenberg DM, et al. Mind-body medicine: State of the science, implications for practice. *J Am Board of Fam Pract*. 2003; 16 (2): 131-147
10. Davidson RJ, Kabat-Zinn J, Schumacher J, et al. Alterations in brain and immune function produced by mindfulness meditation. *Psychosom Med*. 2003; 65(4): 564-570
11. Saper RB, Eisenberg DM, Davis RB, et al. Prevalence and patterns of adult yoga use in the United States: results of a national survey. *Altern Ther Health Med*. 2004; 10(2):44-49
12. Oken BS, Zajdel D, Kishiyama S, et al. Randomized, controlled, six-month trial of yoga in healthy seniors: effects on cognition and quality of life. *Altern Ther Health Med*. 2006; 12(1):40-47.

13. Banerjee B, Vadiraj HS, Ram A, et al. Effects of an integrated yoga program in modulating psychological stress and radiation-induced genotoxic stress in breast cancer patients undergoing radiotherapy. *Integr Cancer Ther.* 2007; 6(3): 242-250
14. Vera F, Manzanque JM, Maldonado EF, et al. Subjective sleep quality and hormonal modulation in long-term yoga practitioners. *Biol Psychol.* 2009; 81:164-168
15. Prakash S, Meshram S, Ramtekkar U. Athletes, yogis and individuals with sedentary lifestyles; do their lung functions differ?. *Indian J Physiol Pharmacol.* 2007;51(1): 76-80.
16. Hill K, Smith R, Fearn M, et al. Physical and psychological outcomes of a supported physical activity program for older carers. *J Aging Phys Act.* 2007; 15 (3): 257-271.
17. Michalsen A, Grossman P, Acil A, et al. Rapid stress reduction and anxiolysis among distressed women as a consequence of a three-month intensive yoga program. *Med Sci Monitor.* 2005; 11(12):CR555-561.
18. Krisanaprakornkit T, Krisanaprakornkit W, Pivavahatkul N, et al. Meditation therapy for anxiety disorders. *Cochrane Database Sys Rev.* 2006, 25 (1): CD004998
19. Smith C, Hancock H, Blake-Mortimer J, et al. A randomized comparative trial of yoga and relaxation to reduce stress and anxiety. *Complement Ther Med* 2007; 15 (2): 77-83.
20. Streeter CC, Whitfield TH, Owen L et al. Effects of Yoga versus walking on mood, anxiety, and brain GABA levels: A randomized controlled MRS study. *J Altern Complement Med* 2010; 16 (11): 1145-1152.
21. Sahay BK: Role of yoga in diabetes. *J Assoc Physicians India.* 2007; 55: 121-126
22. Innes KE, Vincent HK, Taylor AG. Chronic stress and insulin resistance-related indices of cardiovascular disease risk, part 2: a potential role for mind-body therapies. *Altern Ther Health Med.* 2007; 13 (5): 44-51.
23. Chou R, Qaseem A, Snow V, et al. Clinical Efficacy Assessment Subcommittee of the American College of Physicians; American College of Physicians; American Pain Society Low Back Pain Guidelines Panel.: Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. *Ann Intern Med.* 2007; 147 (7): 478-91.
24. Astin JA. Mind-body therapies for the management of pain. *Clin J Pain* 2004; 20 (1): 27-32
25. Carlson LE, Speca M, Farris, Patel KD. One year pre-post intervention follow-up of psychological, immune, endocrine and blood pressure outcomes of mindfulness-based stress reduction (MBSR) in breast and prostate cancer outpatients. *Brain Behav Immun.* 2007; 21(8): 1038-1049.
26. Elavsky S, McAuley F: Physical activity and mental health outcomes during menopause: a randomized controlled trial. *Ann Behav Med.* 2007; 33 (2): 132-142
27. Yurtkuran M, Alp A, Yurtkuran M, Dilek K. A modified yoga-based exercise program in hemodialysis patients: a randomized controlled study. *Complement Ther Med.* 2007; 15 (3): 164-171
28. Manzanque JM, Vera FM, Maldonado EF, et al. Assessment of immunological parameters following a qigong training program. *Med Sci Monitor.* 2004; 10 (6): CR264-270.
29. Khatri D, Mathur KC, Gahlot S, Jain S, Agrawal RP: Effects of yoga and meditation on clinical and biochemical parameters of metabolic syndrome. *Diabetes Res Clin Pract.* 2007, 78 (3): e9-e10.
30. Gordon, L.A., Morrison, E.Y., McGrowder, D.A., et al. 2008. Effect of exercise therapy on lipid profile and oxidative stress indicators in patients with type 2 diabetes. *BMC Complement Altern Med* 2008; 13: 21.
31. De Boer D, Ring C, Curlett AC, et al. Mental stress-induced hemoconcentration and its recovery: a controlled study of time course and mechanisms. *Psychophysiol.* 2007; 44 (1): 161-169.
32. Malthotra V, Singh S, Tandon OP, Sharma SB: The beneficial effect of yoga in diabetes. *Nepal med Coll J.* 2005; 7: 145-147
33. Muldoon MF, Herbert TB, Patterson SM, et al. Effects of acute psychological stress on serum lipid levels, hemoconcentration, and blood viscosity. *Arch Intern Med.* 1995; 155(6): 615-620.
34. Zraggen L, Fischer JE, Mischler K, et al. Relationship between hemoconcentration and blood coagulation responses to acute mental stress. *Thromb Res.* 2005; 115(3), 175-183.
35. Mischler K, Fischer JE, Zraggen L, et al. The effect of repeated acute mental stress on habituation and recovery responses in hemoconcentration and blood cells in healthy men. *Life Sci.* 2005; 77 (10): 1166-1179.
36. De Boer D, Ring C, Wood M, et al. Time course and mechanisms of mental stress-induced changes and their recovery: hematocrit, colloid osmotic pressure, Whole blood viscosity, coagulation times, and hemodynamic activity. *Psychophysiol.* 2007; 44 (4): 639-649.
37. Parshad O. Role of yoga in stress management. *West Indian Med J.* 2004; 53(3): 191-194
38. Voeikov VL, Dmitriev Aiu: Biophysical mechanisms of the erythrocyte sedimentation reaction. *Biofizika.* 1998; 43 (4): 575-579
39. Rotstein R, Landau T, Twig A y col: The erythrocyte adhesiveness/aggregation test (EAAT). A new biomarker to reveal the presence of low grade subclinical smoldering inflammation in individuals with atherosclerotic risk factors. *Atherosclerosis.* 2002; 165: 343-351.
40. Berliner S, Zeltser D, Shapira I y col: A simple biomarker to exclude the presence of low grade inflammation in apparently healthy individuals. *J Cardiovasc Risk.* 2002; 9: 281-286.
41. Fusman G, Mardi T, Justo D y col: Red blood cell adhesiveness/aggregation, C-reactive protein, fibrinogen, and erythrocyte sedimentation rate in healthy adults and in those with atherosclerotic risk factors. *Am J Cardiol.* 2002; 90: 561-563.
42. Erikssen G, Liestol K, Bjornholt JV y col: Erythrocyte sedimentation rate: a possible marker of atherosclerosis

- and a strong predictor of coronary heart disease mortality. *Eur Heart J.* 2000; 21: 1614-1620.
43. Vitrichenko EE: Erythrocyte function of rats under emotional stress. *Biull Eksp Biol Med.* 1985; 100(12): 675-677
 44. Ospina MB, Bond K, Karkhaneh M, et al. Meditation practices for health: state of the research. *Evid Rep Technol Assess (Full Rep).* 2007; 155: 1-263
 45. Danesh J, Collins R, Peto R, et al. Haematocrit, viscosity, erythrocyte sedimentation rate: meta-analysis of prospective studies of coronary heart disease. *Eur Heart J.* 2000; 21(7): 515-520
 46. Erikssen, G., Liestol, K., Bjornholt, et al. Erythrocyte sedimentation rate: a possible marker of atherosclerosis and a strong predictor of coronary heart disease mortality. *Eur Heart J.* 2000; 21(19): 1614-1620
 47. Rapaport E. Erythrocyte sedimentation rate: is it a useful risk marker for coronary heart disease? *Eur Heart J.* 2000; 21: 1567-1569
 48. Bernardi L, Passino C, Spadacini G, et al. Reduced hypoxic ventilatory response with preserved blood oxygenation in yoga trainees and Himalayan Buddhist monks at altitude: evidence of a different adaptive strategy? *Eur j Appl Physiol.* 2007; 99(5): 511-518
 49. Sivasankaran S, Pollard-Quintner S, Sachdeva R, Pugada J, Hoq SM, Zarich SW: The effect of a six-week program of yoga and meditation on brachial artery reactivity: do psychosocial interventions affect vascular tone?. *Clin Cardiol.* 2006; 29(9): 393-398