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RESEARCH ARTICLE

Comparative effect of treadmill and yoga on malondialdehyde level in normal young adults

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ABSTRACT

Background: Stress level can be estimated by evaluating the malondialdehyde (MDA) levels produced from lipid peroxidation of polyunsaturated fatty acids. Accordingly, a holistic health care approach (instead of a conventional drug-based approach alone) for the treatment is highly recommended; development of a mind-body medicine or an inclusive approach of mind-body interactions is the need of the hour. Thus, the effect of yoga which comprises pranayama, asana, and meditation is more relaxing than the well-equipped gym schools of today which are very lucrative and attractive, but they are costly means of fitness. Yogic exercises are more relaxing and cost effective. **Aims and Objectives:** The purpose of this study is to compare and see the effect of treadmill exercise and yoga on oxidative stress. **Materials and Methods:** An observational study was conducted in Exercise Physiology Laboratory, Department of Physiology (Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Sawangi Meghe, Wardha, Maharashtra, India). 50 male subjects of age group 18-20 years, were divided into two groups, treadmill exercise (Group A) and yoga (Group B) consisting of 25 each. On regular exercise, subjects were assessed at the start of and after 3 months of the training schedule (45 min/5 days/week). Blood samples were collected to assess the MDA levels before and after the intervention. The parameter assessed were vital parameters (heart rate and pulse rate), VO_2 max; they were also assessed for their social and environmental behavior by WHO-quality of life questionnaire. Results were compared using Student paired *t*-test and unpaired *t*-test and age-wise distribution by Chi-square test. **Result:** Results showed that the pre-exercise levels of MDA in Group A (1.30 ± 0.1) and Group B (1.23 ± 0.1) and the postexercise levels in Group A (0.92 ± 0.2) and Group B (0.37 ± 0.2). There was an increase in the vital parameter in Group A, whereas no significant changes were observed in Group B. VO_{2max} levels state that the oxygen requirement is more for Group A than Group B. **Conclusion:** The study concludes that yoga has more beneficial effect than the treadmill exercise which helps to decrease the free radical production.

KEY WORDS: Treadmill Exercise and Yoga; Oxidative Stress; Free Radicals; Malondialdehyde

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INTRODUCTION

It has been observed that medical school environments in India are extremely stressful to some students and has led to suicide and suicidal attempts by the students. Fear of failure, vast content that has to be mastered, inability to cope with the high expectations of parents and peers are found to be

most commonly observed sources of stress. In the Indian scenario, too much content is delivered in a short span of time. In addition to that, students are required to undertake too many examinations leading to frustration and depression. Thus, stress can lead to social insecurity as well as poor academic performance.[1] Oxidative stress is a condition characterized by an imbalance between reactive oxygen/nitrogen species (RONS) production and the antioxidant defense system whereby RONS generation exceeds the capacity of the antioxidant defense system to render RONS inactive. As a result of the RONS/antioxidant imbalance, oxidative cellular damage occurs as several macromolecules including lipids, proteins, and nucleic acids are subjected to oxidative modifications.[2]

According to the new hypothesis, exercise-induced RONS generation is necessary during exercise for the initiation of adaptive processes. Mechanistically, it has been proposed that RONS-mediated signaling activates redox-sensitive transcription factors that, in turn, regulate antioxidant and damage repair enzymes. Consequently, these adaptive processes may result in lower basal levels of RONS and a reduction in oxidative damage during exercise.[3]

Several studies have demonstrated that exercise duration may be an important factor related to RONS production, as more prolonged bouts of aerobic exercise have been shown to elicit greater amounts of oxidative damage.[4-6] Indeed, it is well known that exhaustive exercise causes muscle damage, for instance, evidenced as an increase in the plasma activity of cytosolic enzymes such as creatine kinase or lactate dehydrogenase. Free radicals are involved in the pathogenesis of many diseases, such as diabetes, cardiovascular diseases, inflammation, or pulmonary diseases. Free radicals are also involved in important physiological processes, such as aging. Pioneering work by Davies et al. and collaborators showed that free radicals are formed in physical exercise.[7] Free radicals constantly attack body proteins, carbohydrates, fats and DNA, causing potentially serious damage unless checked. Every cell in our body suffers an estimated 10,000 free radical hits each day.[8] Stress level can be estimated by evaluating the malondialdehyde (MDA) levels produced from lipid peroxidation of polyunsaturated fatty acids.[9] Accordingly, a holistic health-care approach (instead of a conventional drug-based approach alone) for the treatment is highly recommended; development of a mind-body medicine or an inclusive approach of mind-body interactions is the need of the hour. Thus, the effect of yoga which comprises pranayama, asana, and meditation is more relaxing than the well-equipped gym schools of today which are very lucrative and attractive, but they are costly means of fitness. Yogic exercises are more relaxing and cost effective. So to compare the beneficial effect of both the exercises, this study was shown in Tables 1-4.

Table 1: Comparison of HR

Groups	Pre	Post	Mean difference	*P* value
Group A (beats/min)	77.92±1.44	201.64±0.48	123.72±0.9	0.002*
Group B (beats/min)	78.92±3.17	77.8±1.19	0.8±2	0.004*

*Statistically significant. HR: Heart rate, SD: Standard deviation

Table 2: Comparison of VO_{2max}

VO_{2max} (ml/min)	Group A	Group B	Mean difference	*P* value
Postintervention	36.44±1.08	33.0±1.2	3.44±0.12	0.002*

*Statistically significant. SD: Standard deviation

Table 3: Comparison of WHO-QOL

Domains	Group A	Group B	*P* value
Physical	8.56±2.3	14.52±2.4	0.003*
Psychological	9.48±3.3	13.88±2.4	0.001*
Social relationship	10.20±3.9	12.72±4.2	0.003*
Environmental	8.52±3.6	10.96±5.4	0.003*

*Statistically significant, SD: Standard deviation, QOL: Quality of life

MATERIALS AND METHODS

Type of Study

Type of the study is comparative interventional study.

Study Area

The selection and screening of subjects were conducted at Exercise Physiology Laboratory, Department of Physiology, Jawaharlal Nehru Medical College (JNMC), Sawangi (Meghe), Wardha, Maharashtra, India. Treadmill tests were conducted at the Electrophysiology Laboratory at Acharya Vinoba Bhave Hospital, Sawangi (Meghe), Wardha, Maharashtra, India.

Selection of Subjects

After obtaining approvals from the Institutional Ethics Committee and the institutional authorities, students aged 18 years and above, of either sex, who had enrolled for the 1st-year of the Bachelor of Medicine, Bachelor of Surgery course at JNMC were explained about the study. Those with a history of any type of medical illness and those below 18 years of age were excluded from the study. From among those students (all males between 18 and 20 years of age) who gave written informed consent, subjects were randomly allocated by blind-chit (lottery) method into two Groups A and B, each group comprising 25 subjects.

Table 4: Comparison of MDA levels

MDA nmol/ml	Group A			Group B			*P* value
	Pre	Post	Difference	Pre	Post	Difference	
	1.30±0.1	0.92±0.2	0.38±0.1	1.23±0.1	0.37±0.2	0.9±0.1	0.01*

*Statistically significant. MDA: Malondialdehyde

Intervention for Group A

After giving information, all subjects in Group A underwent treadmill exercise as per Bruce protocol.[10] Bruce protocol is a maximal exercise test, where the subject works to complete exhaustion as the treadmill speed and incline is increased every 3 min. The total duration of workout was 45 min/day for 5 days/week for 12 weeks (initial warm up for 5 min followed by intervention of 35 min and ending the procedure with 5 min relaxation). 30 settings of 45 min were given each on alternate day for 12 weeks. This was followed by once a week interview during which, the method followed by the patients was checked and any queries related to the methodology were answered. During the test, heart rate (HR), and blood pressure were recorded. During this time, subjects were instructed to sit or rest, refrain from eating and were only allowed to drink up to 1 L of water.

A person was made to walk on the treadmill (RMS, Ambala) thus implying the Standard Bruce Protocol for the subjects, who are active and devoid of any diseases. Subjects were instructed to press the red knob on the treadmill or raise hand to stop the test, in case of any discomfort. All tests were done at 1.74 mph walking with an increment of grade by 2% at every 3 min interval. The average grades achieved by all the students are 16-18%. Electrocardiogram was continuously monitored, and the treadmill test was terminated when the subject reached 75-80% of their estimated HR reserve.[10] Subjects performed the exercise for 30 min/day for 5 days a week for 3 months, after which their blood samples from capillaries were collected, mostly in the morning (8 am to 11 am). All subjects remained in the electrophysiology lab during their postexercise sample collection for 1 h to keep control on their food and water intake.

Intervention for Group B

After providing information, subjects in Group B underwent yogic exercise program comprising pranayam (breathing exercises), asana (physical postures), and Rajyoga meditation (mental relaxation exercise) lasting 45 min/day for a total duration of 12 weeks. They were made to relax for 5 min and then they were allowed to practice asanas for 15min. Asana[11] (Sanskrit word meaning "sitting down") is a body position, typically associated with the practice of yoga, originally identified as a mastery of sitting still. Three types of asanas were included suryanamaskar[12] and tadasana.[13] The asanas were followed by pranayam (anulom-vilom and kapalbhati).[14] After rest for 5 min, Rajyoga meditation[15] was practiced for 15 min in a quiet, dimly lit room. A total of 7 orientation classes each of 45 min were delivered by the Raj yoga specialist, of which last 20 min are devoted to a guided audio clip. All of them were required to note about the experience of the meditation practice in their diary. Review was taken in the department after every 15 days. The yogic exercise ended with 5 min relaxation. Subjects were closely monitored and exercise was put on hold in case of slight discomfort. Subjects were called every week and compliance was noted.

Blood Sample Collection

Blood samples (2 ml of capillary blood) were collected aseptically in plain bulb in a quiet room after the subject had 10 min of adjustment in the supine position. The samples were collected before the commencement of intervention and after 12 weeks of intervention. Any blood samples displaying evidence of hemolysis were discarded and not stored for assay.

Parameters

Body mass index (BMI)

The BMI was calculated by dividing the weight (in kg) by the square of height (in m).[16] Height was measured in centimeters using a measuring tape (Medscope Ltd, Marsden H-630, Cirencester, UK) fixed on wall with the subject standing barefoot. Weight was measured in kilograms on a digital weighing scale (Omron HN-286 Digital weight scale, Haryana), with subject in minimum clothing.

HR

HR was typically used as a measure of exercise intensity in Group A.[17] During the intervention, HR for Group A was recorded on the treadmill (at rest before the increment of the speed and HR max where the subject attains the exhaustion) and expressed as beats/min, whereas for Group B, HR was recorded in terms of pulse rate.

Normal: HR at rest = 60-80 bpm[17]

Pulse rate

Pulse rate was counted in sitting position for Group B. At rest: 60-100 beats/min.[18]

VO_{2max}

VO_{2max} is the maximum capacity of an individual's body to transport and use oxygen during incremental exercise,

which reflects the physical fitness of the individual. Group A subjects performed an incremental exercise on the Treadmill (RMS, Ambala) connected to a computer software. According to the Bruce Protocol, workload was increased every 3 min with an increased elevation for every 10% grade until the end of the exercise. This procedure was designed to reach a maximal oxygen uptake (VO_{2max}) in young adults.[19] The average untrained healthy male VO_{2max} is approximately 35-40 mL/kg min.[20] The incremental test was considered as maximum if at least three of the following criteria were observed: (a) Exhaustion of the subject or inability to maintain the required walking speed in spite of verbal encouragement, (b) VO_{2max} plateau was reached and (c) the predicted maximum HR (HR_{max}) was reached.

$$VO_{2max} = 15 \times HR_{max}/HR_{rest}$$

Pre and post WHO-quality of life (QOL) assessment

Subjects of both the groups were given WHO-QOL to assess the QOL and health. The questions were read out to the subjects, along with the response options and were told to tick the desired option that appears most appropriate. The WHO-QOL-BREF (Field Trial Version),[21] containing 26 questions, was used to calculate four domain scores. The mean score of items within each domain was used to calculate the domain score. Mean scores were then multiplied by four to make domain scores comparable with the scores used in the WHO-QOL-100. The first transformation method converts scores ranging from 4 to 20, compared with the WHO-QOL-100. The second transformation method converts domain scores to a 0-100 scale. Where more than 20% of data is missing from assessment, the assessment was discarded.

MDA

Fresh blood serum analyzed within 6 h of separation was taken in three clean test tubes and named as blank, standard and test. 2 ml of trichloroacetic acid solution was added to each of the tubes. 800 µl of thiobarbituric acid solution was added to all of them. Then, 200 µl of distilled water was added to blank test tube. 200 µl working MDA standard was added in standard test tube. 200 µl serum was added in test tube. Finally, each tube had 3 ml of solution in it. Then, all the test tubes were kept in boiling water bath for 20 min. Next, the water bath was switched off and further the test tubes were kept for 10 min more. After that, the test tubes were cooled under tap water and centrifuged at 3000 rpm for 1 min. Readings were taken immediately on ultraviolet–visible spectrophotometer (Manti Lab MT-138A, Wide range Silicon Photodiode) at 531 nm wavelength and the reading was noted down.[22]

Statistical Analysis

Results were analyzed by SPSS 22.0 Windows version (IBM Corporation, Armonk, NY, USA). All the data were analyzed group-wise by descriptive statistics using mean and standard deviation. For age-wise distribution of both the groups, Chi-square test was used. The intragroup pre- and post-intervention data were analyzed using Student's paired *t*-test. Intergroup data were analyzed using Student's unpaired *t*-test. The statistical significance was considered at $P < 0.05$

RESULTS

A total of 50 male participated in this study. The entire group had a mean age of 20 ± 1.02 years. The total duration of the exercise protocol was 45 min/day for 5 days a week for 3 months. The pre- and post-intervention values of HR in Group A was 77.92 ± 1.4 beats/min and 201.64 ± 0.4 beats/min, respectively. Whereas in Group B preintervention was 78.92 ± 3.17 and postintervention was 77.8 ± 1.19.

The VO_{2max} in Group A postintervention was 36.44 ± 1.08 whereas; in Group B, it was 33.0 ± 1.2.

WHO-QOL responses in Table 2 shows that in Group A; there was more progressive data in social relationship 10.20 ± 3.9 than those in physical 8.56 ± 2.3, psychological 9.48 ± 3.3, and environmental domains 8.52 ± 3.6. Whereas, Group B subjects showed a significant increase in physical 14.52 ± 2.4, followed by psychological 13.88 ± 2.4, social relationship 12.72 ± 4.2 and environmental 10.96 ± 5.4 domains.

The preintervention value of MDA in Groups A and B was 1.30 ± 0.1 and postintervention value in Group A reduced to 0.92 ± 0.2 whereas in Group B it reduced to 0.37 ± 0.2.

DISCUSSION

Hassan, Udupa et al., and Pal et al. HR increases as you exercise to deliver more blood and oxygen to your working muscles. Thus, it was proved that the severe intensity exercise increases the sympathetic activity on heart and thus reduces parasympathetic activity. Once exercise begins, there is substantial stimulation of the sympathetic nervous system.[23-25] This sympathetic discharge increases HR by increasing the pace of SA node depolarization (Guyton and Hall 1956). The moderate intensity exercise does not just strengthen the muscles but it also strengthens once heart and keeps blood vessels healthy.[26]

The data of Table 2 is in line with the findings of Hovsepian et al., Kodgire and Dnyanoba. Thus, they found that oxygen consumption was more in treadmill exercise rather than yogic exercises. The increase level of oxygen also improves the ventilatory system by increasing the respiratory muscle strength. The findings thus conclude that on severe intensity exercise, oxygen consumption rate of an individual is raised as compared to the moderate intensity exercise.[27,28] Thus, on

moderate-intensity the exhaustion of oxygen is less which help to distress the body.

The data in Table 3 shows that the QOL should be improved in the following manner physically followed by psychologically, social relationship and last the environment which is in line with the findings of Manocha and Black and Bankar et al. Thus, it is found that physical and psychological domains play a key role in the improvement of social and physical well-being of a person.[29,30]

In Table 4, data are in line with the findings of Miyazaki et al., Cheong and Lim, Kumari and Gowda. Thus, relaxing exercises are more significant in reducing MDA levels than that by strenuous exercises.[31-33] Whereas, the findings of Bloomer et al. and Dayan et al. were in contrast to our findings. As they showed increase in lipid peroxidation or no effect on the free radical formation by moderate intensity relaxing exercises.[34,35] However, it has been proved that strenuous intensity exercises lead to production of ROS which further leads to lipid peroxidation in the mitochondria and thus forms free radicals in the body which cause strenuous effects. These free radical formation can lead to many pathophysiological conditions such as diabetes, hypertension, neural damage, and chronic diseases.

Limitations

Due to the availability of subjects for limited time the study was not able to continue for a longer duration.

The study was focused on the male subjects as female subjects were not willing to give their informed consent.

CONCLUSION

Thus, from the above study, it can be concluded that yoga which is considered as a relaxing technique is more beneficial than treadmill exercise which is a strenuous exercise as it can lead to exhaustion of oxygen leading to free radical formation.

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