

Comparative Study of Yoga and Physical Exercises on Psychological Parameters, Hand Grip Strength and Reaction Time during Examination Stress in Young Female Medical Students

Vivek K Sharma^{1*}, Ajay Kukreja², Senthil Kumar S³, Sarita Kanojia⁴ and Shailesh Gupta⁵

¹Assistant Professor, Dept of Physiology, JIPMER, Puducherry, India

²Associate Professor and Head, Dept of Physiology, ESI Dental College, New Delhi, India

³Senior Resident, Dept of Physiology, JIPMER, Puducherry, India

⁴Assistant Professor, Dept of Physiology, ESI Dental College, New Delhi, India

⁵Assistant Professor, Dept of Physiology, IMS, BHU, Varanasi, India

Abstract

Present study is a non-randomized trial and was conducted on 90 MBBS female students (first year) who assigned into following groups-yoga group (Group 1), physical exercise group (Group 2) and control group (Group 3) (n=30). Group 1 subjects practiced yogic exercises, Group 2 practiced exercises on bicycle ergometer for 40 minutes daily for twelve weeks and Group 3 acted as control. Formative examinations were conducted at 6 weeks (stressor 1) and 12 weeks (stressor 2). Following recordings were taken at baseline, stressor 1 and 2: Auditory (ART) & Visual reaction time (VRT), Handgrip strength endurance (HGE), Spielberger's State anxiety inventory for adults (STAI-A) and inventories developed by Defense Institute for Physiology & Applied Sciences. There was significant decrease in trait anxiety and depression scores at both stressors in both the groups with significant reduction in depression score from stressor 1 to 2 in only group 1 subjects. Significant decrease occurred in STAI-A scores in Group 1 subjects at both stressors ($p < 0.001$) with no change observed in Group 2 subjects. Significant improvement occurred in sense of wellbeing at both stressors 1 and 2 ($p < 0.001$) in Group 1 subjects whereas improvement in Group 2 subjects occurred only at stressor 2 ($p < 0.01$). Significant improvement in HGE was observed in both groups at both stressors. Also, significant reduction in ART was observed in only Group 1 subjects ($p < 0.05$) at stressor 2 with no change seen in Group 2 subjects. No longitudinal changes were observed in control group. Our study demonstrates that both forms of intervention i.e. yoga training and physical exercises are beneficial for the subjects in reducing the effect of examination stress on tested parameters but the effect of yoga is immediate and more pronounced on all parameters except HGE.

Keywords: Yoga regimen; Physical exercise; Psychological parameters; Hand grip endurance; Reaction time

Introduction

Stress is defined as an organism's total response to environmental demands or pressures. Stress in humans results from interactions between persons and their environment that are perceived as straining or exceeding their adaptive capacities and threatening their well-being. The element of perception indicates that human stress responses reflect differences in personality, physical strength as well as general health. Medical education is well known to be highly competitive in nature and previous studies have already documented that perceived stress scores are higher in medical students compared to other age controlled students [1,2] which accentuates during examination. Stressful condition of students taking examination can be considered as a good model of naturalized stress in human beings as compared with laboratory-induced stress situations. Level is higher in the female students compared to the male students. Exercise and yoga are known to play an important role in reducing the stress. A growing body of evidence supports the belief that yoga benefits physical and mental health via down-regulation of the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS) [3]. Malathi et al. [4] have reported that there is significant reduction in examination stress with better academic performance and sense of well-being in students who practiced yoga. The studies comparing the effects of yoga and exercise seem to indicate that, in both healthy and diseased populations, yoga may be as effective as or better than exercise at improving a variety of health-related outcome measures [3]. Hence, we have proposed to study and compare the effects of yoga and physical

exercise on psycho-physiological parameters in young female medical students.

Materials and Methods

Study design

Present study is a non-randomized control trial. Prior permission was taken from the institutional ethical committee. Lady Hardinge medical college, New Delhi, India offers MBBS course only for girl candidates, hence, only female subjects in the age group of 18-20 years were selected for the present study. After meeting inclusion and exclusion criteria of the study, consecutive, 90 first year MBBS female student volunteers were selected and enrolled into the study after getting written informed consent. Based on their preference for yogic training or physical exercises, students were divided into two groups as follows:

Group1 (n=30): subjects who underwent yoga training.

***Corresponding author:** Vivek K Sharma, Assistant Professor, Dept of Physiology, JIPMER, Puducherry, India, E-mail: drviveksharma@yahoo.com

Received July 02, 2012; **Published** September 26, 2012

Citation: Sharma VK, Kukreja A, Senthil Kumar S, Kanojia S, Gupta S (2012) Comparative Study of Yoga and Physical Exercises on Psychological Parameters, Hand Grip Strength and Reaction Time during Examination Stress in Young Female Medical Students. 1:362. doi:[10.4172/scientificreports.362](http://dx.doi.org/10.4172/scientificreports.362)

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Group 2 (n=30): subjects who practiced physical exercises (PE) on stationary bicycle.

Group 3 (n=30): subjects who did not participate in any exercise intervention and acted as controls.

Inclusion criteria

- Healthy female subjects in the age group of 18-20 years.

Exclusion criteria

- Subjects who have practiced any other yogic exercises including meditation or biofeedback relaxation technique in past one year.
- Subjects who have participated in athletic events in past one year.

Intervention for both the groups (i.e. yogic exercises for Group 1 subjects and physical exercises for Group 2 subjects) was given for 40 minutes daily, six times per week for the duration of 12 weeks. All the subjects were then assessed thrice during the study as follows:

1. Baseline recordings when no examination stress was given (No stress)
2. 6 weeks later formative assessment examination was conducted and recordings were taken one day before the examination (Stressor 1)
3. 12 weeks later, another formative examination was conducted and recordings were taken just before the examination (Stressor 2)

Yoga training

To ensure regularity and uniformity, yoga training was given by qualified yoga trainer from Moraji Desai National Institute of Yoga (MDNIY). Before the beginning of yogic training, yoga trainer familiarized Group 1 subjects with different theoretical aspects of yogic practices and technique of meditation was taught in a series of 5 lectures. Following yoga techniques were daily practiced.

- Sukshma Vyayam (minor exercise) 3 minutes
- Sthula Vyayama (macro/major exercise) 3 minutes
- Pranayam 5 minutes
 - o Nadishodhan
 - o Bhramari
- Asanas (postures): 20 minutes
 - o Suryanamaskar
 - o Urdhvahastottasan
 - o Katichakrasan
 - o Konasan
 - o Paschimottanasan
 - o Vajrasan
 - o Mandukasan
 - o Gaumukhasan
 - o Ardhamatsyendrasan
 - o Padmasan
 - o Dhanurasan
 - o Bhujangasan

- Shavasana: 2 minutes
- Dhyana (meditation): 7 minutes
 - o “Om” chanting
 - o Rajyog

Physical exercises

Group 2 subjects were administered exercises as follows using computerized bicycle ergometer (ergoline 900 supplied by Jaeger, Germany)

- Stretching exercises: 5 minutes
- Warm up exercise on bicycle for 5 minutes at the initial load of 20 watts followed by exercising at 55-75% of maximum heart rate calculated by formula $HR_{max} = 220 - \text{Age (years)}$ for 20 minutes. Cool down exercise for 5 minutes by pedalling at 20 watts.
- Stretching exercises: 5 minutes.

All the subjects (n=90) were asked to be present on the day of assessment between 9 AM to 11 AM at least 2 hours after taking light breakfast. All the subjects were then assessed on following tests:

Physiological parameters

1) Handgrip strength endurance (HGE): Handgrip dynamometer (supplied by INCO, Ambala, India) was used for the study. The subjects were asked to pull the grip with 80% (T_{max} 80%) of their maximum (T_{max}) capacity and duration of time they are able to hold gives the handgrip strength endurance in seconds.

2) Audio & visual reaction time (ART & VRT): It was recorded on RTM 608 Audio-visual reaction time apparatus (supplied by MEDICAID systems, Chandigarh, India) in a room at 25°C. After familiarizing the subjects with RT apparatus on two different occasions, subjects were asked to use the index finger of dominant hand for pressing response switch. Auditory stimulus was beep tone and visual stimulus was red light. The mean of 3 similar readings from a minimum of 10 readings was considered.

Psychological tests

1. Spielberger's State Anxiety Inventory Scale for adults (STAI-A): State anxiety is a 'transitory' emotional state that is characterized by subjective, consciously perceived feelings of tension & stress. This scale has twenty questions with a range of four possible responses to each.

2. Inventories developed by Defence Institute for Physiology & Applied Sciences, India (DIPAS) were used to measure traits of anxiety, depression and well-being as they are valid for Indian population.

- Trait Anxiety: State anxiety may fluctuate over time and can vary in intensity. In contrast, trait anxiety denotes "relatively stable individual differences in anxiety proneness" and refers to a general tendency to respond with anxiety to perceived threats in the environment and various situations. This questionnaire consists of 40 items and the total score ranges from 0 to 120. Ideal score is <40.

- Depression: This scale consists of 10 items which takes into consideration variables like depressed mood, guilt, difficulty in sleeping, decision making, work and interests. Optimal score is <3.

- Sense of well-being: It refers to that positive attribute, which enables the person to reach enhanced levels of mental health, even if the person does not have any diagnosed mental health condition.

This questionnaire consists of 50 questions and assesses individual on various aspects of subjective well-being including the ability to develop persons' potential; work productivity and creativity; build strong and positive relationships with others; and contribute to the community. Optimal score is <40.

Statistical analyses

Data was recorded and analyzed statistically by PASW version 16. For each variable group, mean and standard deviation of the mean scores were calculated according to accepted statistical methods. The normality of the continuous data was tested by using Kolmogorov-Smirnov test. Intergroup mean differences in the parameters were tested for significance by using one way ANOVA. For intra-group comparisons, Wilcoxon sign rank test was used. All statistical analysis was carried out at 5% level of significance and P value <0.05 was considered as statistical significant.

Results

Table 1 shows the comparison of baseline levels of tested physiological and psychological parameters between subjects of three groups. Group 1 subjects have higher STAI-A and well-being scores. This demonstrates that at baseline, Group 1 subjects were having significantly higher anxiety and lesser feeling of well-being as compared to Group 2 subjects.

Table 2 demonstrates changes occurring in all the tested physiological and psychological parameters in both the groups from baseline level to stressor 1 and stressor 2 and also compares the differences obtained between group 1 subjects and group 2 subjects at stressor 1 and stressor 2. Results are explained later in discussion.

Discussion

Group 1 subjects were having significantly higher anxiety and lesser feeling of well-being as compared to Group 2 subjects at the baseline. It cannot be explained by the study, but probably it shows that more anxiety prone individuals with lesser well-being feeling chose integrated yoga over stationary bicycle. In our study, it was observed that there was significant fall in the STAI-A scores in Group 1 subjects both at stressor 1 and 2 as compared to baseline. This significant reduction in STAI-A scores also continued from stressor 1 to 2. This shows that yoga practice significantly decreased 'state anxiety' in Group 1 subjects. Since state anxiety is transitory emotional state which increases with stressor, our study shows that yoga enabled group 1 subjects to remain calm and less anxious in the event of examination stress. There was

Parameter	Group 1	Group 2	Group 3
Age (years)	18.1 ± 0.9	17.1 ± 0.1	18.5 ± 0.34
Height (cm)	156.9 ± 8.9	157.1 ± 5.8	158.1
Weight (kg)	50.9 ± 8.8	50.4 ± 6.4	51.1 ± 3.4
STAI-A	52.30 ± 8.0	39.4 ± 10.8***	49.03 ± 12.54
Depression	14.7 ± 4.3	12.6 ± 4.0	11.33 ± 3.7
Trait anxiety	48.5 ± 5.7	51.20 ± 7.5	51.10 ± 6.08
Sense of wellbeing	74.1 ± 21.6	58.6 ± 21.0**	57.96 ± 16.10
Handgrip Dynamometer endurance (sec)	6.4 ± 1.9	6.10 ± 2.1	5.8 ± 3.2
Auditory Reaction time (msec)	225.7 ± 54.8	218.6 ± 54.8	219.8 ± 27.4
Visual reaction time (msec)	266.7 ± 54.8	260.8 ± 54.8	276.9 ± 55

NS: Non significant, *: changes between Group 1 & 2, ** p<0.01, *** p<0.001, One way ANOVA test

Table 1: Comparison of basal parameters (Mean ± SD).

Parameters	Group	Basal	Examination stressor 1	Examination stressor 2
State anxiety	Yoga	52.31 ± 8.01	49.33 ± 6.65***	46.60 ± 6.20***##
	Physical group	39.40 ± 10.85	38.40 ± 9.1	39.83 ± 8.8
	Control group	49.03 ± 12.54	48.90 ± 11.56	50.00 ± 12.05
Trait anxiety	Yoga	48.5 ± 5.6	44.1 ± 6.6***	44.00 ± 7.2***
	Physical group	51.20 ± 7.5	45.6 ± 7.2***	43.70 ± 5.1***
	Control group	51.10 ± 6.08	49.76 ± 7.39	49.73 ± 6.30
Sense of wellbeing	Yoga	74.9 ± 21.6	61.6 ± 23.2***	50.33 ± 16.8***
	Physical group	58.6 ± 21.03	55.3 ± 19.06	50.2 ± 17.9***
	Control group	57.96 ± 16.10	55.76 ± 21.42	58.58 ± 19.77
Depression	Yoga	14.7 ± 4.3	11.20 ± 5.1***	9.8 ± 5.20***#
	Physical group	12.6 ± 4.05	9.80 ± 4.4***	9.90 ± 5.2***
	Control group	11.33 ± 3.7	9.10 ± 5.4	9.0 ± 4.1
Handgrip Dynamometer endurance	Yoga	6.4 ± 1.9	7.30 ± 2.8*	7.3 ± 3.8*
	Physical group	6.1 ± 2.1	6.1 ± 1.6	7.7 ± 3.2*###
	Control group	5.8 ± 3.2	5.5 ± 2.0	7.40 ± 3.5
Auditory Reaction time	Yoga	225.7 ± 54.8	223.2 ± 49.3	216.1 ± 49.3*#
	Physical group	218.6 ± 54.8	217.1 ± 54.8	206.8 ± 54.8
	Control group	219.8 ± 27.4	217.5 ± 27.4	217.0 ± 27.5
Light reaction time	Yoga	266.7 ± 54.8	256.2 ± 49.3	259.1 ± 49.3
	Physical group	260.8 ± 54.8	257.8 ± 54.8	251.1 ± 54.8
	Control group	276.9 ± 55	265.3 ± 54.0	259.9 ± 54.8

Compared with basal value <0.05, ** <0.01, *** <0.001, # Compared with 6 weeks value # <0.05, ## <0.01, ### <0.001

Table 2 demonstrates changes occurring in all the tested physiological and psychological parameters in both the groups from baseline level to stressor 1 and stressor 2 and also compares the differences obtained between group 1 subjects and group 2 subjects at stressor 1 and stressor 2. Results are explained later in discussion.

Table 2: Comparison of basal parameters with examination stress in yoga and physical education group.

no change in STAI-A scores in Group 2 subjects at both stressors as compared to baseline (no stressor) which shows that physical exercises can prevent the rise of anxiety state with stressor but not reduce it. There was significant reduction in trait anxiety in both groups at both stressors (p<0.001) compared to their baseline. Our study is in concordance with previous study done by Malathi and Damodaran [4]. Similarly, decrease in anxiety levels with PE was observed by Kubitz and Landers [5]. These findings suggest that yoga training was more effective than PE in reducing 'state anxiety' of the subjects whereas there was comparable improvement in 'trait anxiety' in both groups.

Our results also show that there was significant decrease in depression score in both groups at both stressors but significant decrease in score from stressor 1 to 2 was seen in only Group 1 subjects. Our results corroborate with findings of previous studies which demonstrated that yoga practice is effective in the management of depression [6-8] and previous studies indicate that individuals who exercised two to three times per week experienced lesser depressive feelings [9].

There was significant improvement in the scores on sense of well-being of the Group 1 subjects at both stressors 1 and 2 whereas; improvement in Group 2 subjects was seen only at stressor 2. In another previous study, it was seen that 12-week yoga intervention was associated with greater improvements in mood and anxiety than a metabolically matched walking exercise [9]. There was significant

improvement in Handgrip endurance (HGE) time in both groups ($p < 0.05$) but there was continued improvement from stressor 1 to 2 in Group 2 subjects. Increase in HGE represents better physical strength and fitness of the individuals. Our results are similar to previous study which concluded that yoga interventions are equal to or superior to exercise in nearly every outcome measured except those involving physical fitness [3]. There was no significant change in control subjects (Group 3) in all tested parameters.

In our study, we found that there is significant reduction in ART at stressor 2 in Group 1 subjects whereas no significant change was seen in Group 2 subjects. There was a trend towards non-significant decrease in VRT seen in both groups at both stressors.

Reaction time (RT) is an index of the processing ability of central nervous system and a simple means of determining sensory-motor performance. Shortening of RT can be explained by increase in sensory-motor conduction velocity and/or faster information processing in the central nervous system [10-12]. Our results are similar to previous studies which found significant reduction in both ART & VRT with yoga training in healthy subjects.

Therefore, our study concludes that both yoga training and PE are beneficial for the subjects, however, effect of yoga training starts earlier and has comparatively more impact on measured psychological & physiological parameters as compared to physical exercises. The stressful condition of students taking examination can be considered as a good model of naturalistic stress in human beings as compared with laboratory-induced stress situations. Stress induces imbalance of the autonomic nervous system (ANS) with decreased activity of parasympathetic nervous system (PNS) and increased activity of sympathetic nervous system (SNS) [13]. Autonomic imbalance is closely associated with anxiety. Clinical studies and experiments in animals have shown that anxiety is associated with changes in neuro-autonomic control [14-17]. Spectral analysis of heart rate variability has confirmed increased indexes of sympathetic modulation reduced indexes of parasympathetic modulation, or both. This demonstrates that both interventions i.e. yoga training and physical exercises for 12 weeks can lead to reduction of stress levels and thereby, preventing the autonomic dysregulation caused by the stressor.

Reduction in perceived stress levels results in lesser negative feelings of anxiety, depression and improved sense of well-being, better sensory-motor performance and hand grip endurance. Previous studies also give evidence of link between high vagal tone and enhanced attention, effective emotion regulation, and organismic responsivity [18].

Differences that have been found between yoga and exercise training may be a result of how the two interventions differ in their effects upon the autonomic tone and HPA axis. Different levels of intensity of exercise have been shown to affect the HPA axis response to acute stress differently [3]. Low-intensity exercise repeatedly has been shown to decrease HPA axis lower cortisol levels [19,20] and higher intensity exercise leads to proportional increases in cortisol [21]. Exercise stimulates SNS, raising plasma catecholamines [22,23] whereas yoga has been shown to lower SNS and therefore, reduces catecholamine level [24]. When a sedentary subject starts practicing moderate intensity physical exercise, it causes stimulation of sympathetic nervous system (SNS), raising plasma epinephrine and norepinephrine. If physical exercise is continued for longer time, it also leads to better autonomic tone and HPA axis regulation.

Yogasanas are low intensity usually non-strenuous exercises which affect HPA axis positively bringing down sympathetic stimulation and significantly decreasing the release of catecholamines. Also, yoga-based practices have been found to correct the under activity of the parasympathetic nervous system (PNS) and GABA systems in part through stimulation of the vagus nerves, the main peripheral pathway of the PNS [13]. As integrated yoga practice includes aspects of exercise (asanas), breath manipulation (pranayama) and relaxation (meditation), effects of yoga are multi-dimensional and have immediate down-regulating effect on both SNS/ HPA axis response to stress [3]. Regular practice of meditation has also been documented to reduce sympathetic activity, balance neuro-endocrine axis and decrease stress and anxiety levels [25,26].

Conclusion

Our study demonstrates that both forms of intervention i.e. yoga training and physical exercises are beneficial for the subjects in reducing the effect of examination stress on tested parameters but effect of yoga practice starts immediately and is more pronounced on most of the tested parameters except HGE. Yoga is a form of low intensity exercise affecting HPA axis positively and reducing the autonomic dysregulation caused by examination stress whereas moderate intensity PE initially stimulates HPA axis and SNS but ultimately also improves autonomic tone with longer duration of practice.

Limitations of study

It is a non-randomized trial and results should be interpreted with potential rater bias. Other forms of physical exercises could not be included.

Acknowledgement

Authors are thankful to the Yoga Instructor for yoga pre-training and the entire student volunteers of first year MBBS for their contribution.

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