

CHAPTER II

REVIEW OF RELATED LITERATURE

Test anxiety is an overwhelming problem for many students. Symptoms of test anxiety diminish test performance, lower self-confidence, increase negative self-talk, and can cause physiological disturbances. In this chapter researcher has presented the research studies on the burden of stress on health and its consequences for a unique population group. To achieve this purpose researcher has explored electronic databases, print journals, periodicals, magazines etc.

2.1 Studies on Anxiety/Stress and Hormonal Changes

Lovallo *et al.*, (1986)¹ conducted a study on 58 male medical students in two successive first-year classes (32 As, 26 Bs defined by interview). They were tested for mood states, perception of work pressure, and for pituitary-adrenal and cardiovascular function during a period of minimal work pressure (no exams for 1 week) and during maximal work pressure (final exam week). All observations were made at the beginning of the school day, while the students were studying course material in the building where classes were held and study modules were located. Perceived stress and self-ratings of dysphoric moods increased significantly (ps less than 0.0005) for both groups during exams compared to no exams. Plasma cortisol concentrations increased significantly (+20%) from no exams to exams for both As and Bs. Heart rate increased significantly to exams (+8%) and did so slightly more for As (+9%) than for Bs (+7%), with As showing significantly higher rates in the work setting at both times. Systolic blood pressure increased non significantly for both groups. The effect of the higher heart rate and the slight systolic

¹ W. R. Lovallo, G. A. Pincomb, G. L. Edwards, D. J. Brackett and M. F. Wilson, "Work pressure and the type A behavior pattern exam stress in male medical students." *Psychosomatic Medicine*. 48, 1, 1986, pp.125-133.

blood pressure rise produced a significantly greater rate-pressure product for As than for Bs at both exams and no exams (p less than 0.005), with As showing a larger rise to exams than did Bs (+11% vs. +8%). Results indicate that the As had a higher level of tonic cardiovascular activation in the work place than the Bs, and that this was additive with the effects of increased work pressure.

The purpose of this study conducted by Weekes *et al.*, (2006)² was to investigate basic methodological issues related to the usage of an examination stress protocol in studies of psychoneuroendocrinology. In this study, 57 undergraduate students served as participants. All subjects provided salivary samples and completed psychological inventories during a low examination stress period and again during a high examination stress period. Salivary samples were analyzed for cortisol. Three major findings were observed. First, the examination stress protocol proved to be an effective trigger of elevations in both psychological measures of stress and in cortisol levels. Second, sex differences were observed in cortisol levels, such that males showed an elevation in cortisol during the high examination stress session whereas females did not. Finally, no significant correlations were observed between elevations in psychological measures of stress and elevations in cortisol levels. These findings suggest that the examination stress protocol used in the present study effectively elevated both psychological stress and cortisol levels. Furthermore, these findings suggest that there are biological differences in how males and females respond to stress. Finally, no evidence was found to suggest a relationship between psychological and hormonal levels of stress. Together, these findings suggest the need to better define and consider the implications of both the specific measures of stress being used and individual differences in the subject samples in psychoendocrine studies.

² Nicole. Weekes, Richard. Lewis, Falgooni. Patel, Jared. Garrison-Jakel, Dale E. Berger and Sonia J. Lupien, "Examination stress as an ecological inducer of cortisol and psychological responses to stress in undergraduate students." *Stress*, 9, 4, 2006, pp.199-206.

Public speaking tasks have been widely used as laboratory stressors in human research. Fewer studies have investigated similar real life situations like oral examinations and results have been inconsistent. The present study by Schoofs, Hartmann and Wolf (2008)³ investigated salivary cortisol (as a marker of hypothalamus–pituitary–adrenal (HPA) activity) and salivary alpha-amylase (sAA as a marker of sympathetic nervous system (SNS) activity) within the context of a university examination. Subjects were 40 undergraduate students who participated in an oral examination. Of these, 20 also participated in a second examination within a few weeks. Cortisol and sAA were measured immediately before and after the examination and on a control day. Additionally, subjects filled out personality questionnaires. A strong anticipatory increase in salivary cortisol and sAA as well as more modest further increases between the pre- and post-measurements were detected during the examination. Sex or oral contraceptive use had no influence on either measure. In addition, no significant differences between the first and second examination were observed. The findings indicate the neuroendocrine stress responses to laboratory stressors and to heralded real life stressors as well as the modulatory variables involved differ from each other.

Brain natriuretic peptide (BNP), a cardiac peptide, has been implicated in the regulation of hypothalamic-pituitary–adrenocortical (HPA) responses to psychological stressors. The influence of academic stress on circulating concentration of the N-terminal fragment of BNP precursor (NT-proBNP), and in relation to the stress hormone (cortisol) response was studied in 170 college students undergoing major examinations (Offer *et al.*, 2010)⁴. Just prior to the examination, they measured self-estimated stress level, systolic,

³ D. Schoofs, R. Hartmann, and O. T. Wolf, “Neuroendocrine stress responses to an oral academic examination: No strong influence of sex, repeated participation and personality traits.” Research Report, 11, 1, 2008, pp.52-61.

⁴ Offer, Amir, Moran, Sagiv, Nir, Eynon, Chen, Yamin, Ori, Rogowski, Yishay, Gerzy, and Ruthie. E. Amir, “The response of circulating brain natriuretic peptide to academic stress in college students.” Stress, 13, 1, 2010, pp.83-90.

and diastolic blood pressure (SBP, DBP), heart rate (HR), plasma levels of cortisol, and NT-proBNP. These parameters were compared to the participants' baseline measurements, taken at the same hour of a different 'control day', without a major examination to induce stress. Hemodynamic variables (SBP, DBP, and HR) increased on the examination day compared with baseline values ($p < 0.001$). Circulating cortisol concentration increased before examinations (+42%, $p < 0.001$). The response to stress was marked by a significant decrease in plasma NT-proBNP concentration (– 40%, $p < 0.001$). The result showed a significant interaction between the cortisol elevation with examination stress and the NT-proBNP reduction ($p = 0.02$). In response to academic stress, the plasma cortisol elevation was accompanied by a marked reduction in plasma NT-proBNP level. These data may indicate that mental stress entails an interface between the HPA axis and the peripheral natriuretic peptide system, leading to reciprocating changes in circulating levels of the corresponding hormones.

Academic examination stress is reported to increase physiological and self-report measures of stress and to decrease immune functioning. Here, Murphy *et al.*, (2010)⁵ investigated biochemical and self-report measures of stress, immune functioning, and academic pressures before and during a midterm examination period. Undergraduate students were asked to complete a measure of global stress, the perceived stress scale (PSS-10), and to indicate their current level of perceived stress. They also answered questions regarding specific academic pressures and provided a saliva sample for cortisol and salivary immunoglobulin-A (S-IgA) quantification. Students showed increased salivary cortisol concentrations and also reported greater acute perceived stress during the examination period compared to the non-examination period. Although cortisol concentrations and perceived stress were significantly higher during the examination period, participants reported

⁵ Lara. Murphy, Randy. Denis, Christopher. P. Ward, Jaime. And L. Tartar, "Academic stress differentially influences perceived stress, salivary cortisol, and immunoglobulin-A in undergraduate students." *Stress*, 13, 4, 2010, pp.366-371.

similar levels of global stress (PSS-10) during both testing sessions. Additional analyses showed a non-significant increase in the level of S-IgA from the non-examination period to the examination period. Specific pressure variables that appeared to contribute to stress regulation during the examination week included the amount of time spent studying and concern about the impact of examinations in the future. By demonstrating measures of chronic examination stress, these findings provide new insight into the complex relationship between examination stress, cortisol, and immune functioning.

Chronic academic stress responses were assessed by measuring mental state, salivary cortisol levels, and the *glucocorticoid receptor (GR)* gene expression in healthy Japanese medical students challenging the national medical license examination (Kurokawa *et al.*, 2011)⁶. Mental states of 17 male and 9 female medical undergraduates, aged 25.0 ± 1.2 years (mean \pm SD), were assessed by the State and Trait Anxiety Inventory (STAI) and the Self-Rating Depression Scale (SDS) 2 months before, 2 days before, and 1 month after the examination. At the same time points, saliva and blood were collected. STAI-state scores peaked 2 days before the examination. Scores on STAI-trait and SDS, and salivary cortisol levels were consistently higher during the pre-examination period. One month after the examination, all these measures had significantly decreased to baseline levels. Real-time reverse transcription PCR showed that this chronic anxious state did not change the expression of the functional *GR* mRNA isoform in peripheral leukocytes, while it resulted in reduced expression of the *GR* isoform 2 days before the examination. These results replicate and extend a significant impact of chronic academic stressors on the mental state of healthy Japanese medical students and suggest a possible association of *GR* gene in response to psychological stress.

⁶ Ken. Kurokawa, Toshihito. Tanahashi, Akiho. Murata, Yoko. Akaike, Sakurako. Katsuura, Kensei Nishida, Kiyoshi. Masuda, Yuki. Kuwano, Tomoko. Kawai, and Kazuhito. Rokutan, "Effects of chronic academic stress on mental state and expression of glucocorticoid receptor and isoforms in healthy Japanese medical students." *Stress*, 14, 4, 2011, pp.431-438.

Experimental and clinical evidence shows that neutrophils play an important role in the mechanism of tissue injury in immune complex diseases through the generation of reactive oxygen species. In this study, Ignacchiti *et al.*, (2011)⁷ examined the influence of academic psychological stress in post-graduate students on the capacity of their blood neutrophils to release superoxide when stimulated by immune complexes bound to nonphagocytosable surfaces and investigated the modulatory effect of cortisol on this immune function. The tests were performed on the day before the final examination. The state-trait anxiety inventory questionnaire was used to examine whether this stressful event caused emotional distress. In this study, the psychological stress not only increased plasma cortisol concentration, but it also provoked a reduction in superoxide release by neutrophils. This decrease in superoxide release was accompanied by diminished mRNA expression for subunit p47^{phox} of the phagocyte superoxide-generating nicotinamide adenine dinucleotide phosphate-oxidase. These inhibitory effects were also observed by *in vitro* exposure of neutrophils from control volunteers to 10⁻⁷ M hydrocortisone, and could be prevented by the glucocorticoid receptor antagonist RU-486. These results show that in a situation of psychological stress, the increased levels of cortisol could inhibit superoxide release by neutrophils stimulated by IgG immune complexes bound to nonphagocytosable surfaces, which could attenuate the inflammatory state.

Laboratory research has demonstrated that social-evaluative threat has an influence on the hypothalamus pituitary adrenal axis (HPA). In two studies Preul, Schoofs, Schlotz and Wolf (2010)⁸ using independent samples, evaluated the anticipatory cortisol response to a written university examination

⁷ M. D. C. Ignacchiti, R. Sesti-Costa, L. F. Marchi, S. Chedraoui-Silva, and B. Mantovani, "Effect of academic psychological stress in post-graduate students: The modulatory role of cortisol on superoxide release by neutrophils." *Stress*, 14, 3, 2011, pp.290-300.

⁸ Diana. Preul, Daniela. Schoofs, Wolff Schlotz, and Oliver. T. Wolf, "The stressed student: Influence of written examinations and oral presentations on salivary cortisol concentrations in university students." *Stress*, 13, 3, 2010, pp.221-229.

($n = 35$) and to an oral presentation ($n = 34$). Saliva samples were collected before and after the examinations and on a control day. Additionally, saliva samples were collected on the day before the written examination and a control day. Results revealed significantly elevated cortisol concentrations on the day prior to the examination; however, this effect occurred only in those participants who had their control day after the examination. Cortisol concentrations were elevated on the examination day, with increased concentrations before but not after the examination. For the oral presentation study, the results revealed substantially elevated cortisol concentrations before and after the oral presentation. Taken together the results indicate that written examinations cause a mild anticipatory HPA response while oral presentations induce a strong HPA response. These findings appear to support the idea that social-evaluative threat is an important factor determining the size of the HPA response to laboratory stressors as well as to real-life stressors.

Stress-induced production of proinflammatory cytokines in the brain and periphery is associated with mental distress. In this study, Kamezaki *et al.*, (2012)⁹ measured changes in levels of salivary cortisol and 50 circulating immune mediators in 28 4th-grade medical students (19 males and 9 females) 7 weeks before, 1 day before, immediately after, and 1 week after an authorized nationwide examination for promotion. Repeated measures ANOVA with multiple testing correction and post hoc tests revealed that the examination significantly increased levels of proinflammatory cytokines (granulocyte colony-stimulating factor, interferon- γ , interleukin (IL)-1 α , and tumor necrosis factor- α), Th2 cytokines (IL-4, IL-5, and IL-13), and -nerve growth factor in association with significant decreases in salivary cortisol levels and anxiety after the examination. These mediators may have a

⁹ Y. Kamezaki, S. Katsuura, Y. Kuwano, T. Tanahashi, and K. Rokutan, "Circulating cytokine signatures in healthy medical students exposed to academic examination stress." *Psychophysiology*. 49, 7, 2012, pp.991-997.

negative impact on the mental state of healthy young adults exposed to naturalistic stressors.

Qureshi *et al.*, (2009)¹⁰ evaluated the changes in blood lipids and blood cortisol along with sympatho-adnergic responses determined by selected haemodynamic parameters during psychological stress. Male participants (n = 114) were randomly selected. They were examined two times, for stress task of viva-voce (degree examination) and during non-stress period. Final selection of participants was depending on stress assessment and their well being. The results revealed that Cortisol, systolic and diastolic blood pressures (SBP and DBP) and heart rate (HR) were significantly increased during stress period with $p < 0.001$ for each parameter. But different blood lipids levels (TC, LDL-C, HDL-C and TG) were detected with different significant levels. The correlations of changed lipids with raised findings of haemodynamics and cortisol were also evaluated. In fact, further studies in population are needed to evaluate the relation of changes in various biological risk factors including IL-9 and sympatho-adnergic activities with stress factors related to social/ environmental problems, especially genetically based psychological factors.

Deinzer *et al.*, (2000)¹¹ examined the time of recovery of [sIgA] alterations associated with academic stress. Twenty-seven participants in a major medical exam and 27 controls not participating in any exam during the study provided daily saliva samples (immediately after awakening), from the 6th day prior to their last exam until the 14th day afterwards, for analysis of salivary IgA. Data were averaged for the last weeks of exams and the first and second week after exams, respectively. The results showed a prolonged

¹⁰ G. M. Qureshi, G. M. Seehar, M. K. Zardari, Z. A. Pirzado, and S. A. Abbasi, "Study of blood lipids, cortisol and haemodynamic variations under stress in male adults." Journal of Ayub Medical College Abbottabad, 21, 1, 2009, pp.158-161.

¹¹ R. Deinzer, C. Kleineidam, R. Stiller-Winkler, H. Idel, and D. Bachg, "Prolonged reduction of salivary immunoglobulin A (sIgA) after a major academic exam." International Journal of Psychophysiology, 37, 3, 2000, pp.219-232.

reduction of sIgA in exam students as compared to controls. Fourteen days post-stress sIgA concentrations of exam students were still significantly lower than control levels ($P=0.004$). No recovery was observable. At the same time exam students and controls did not differ in terms of self-reported stress and recovery. From the results it was concluded that psychological and immunological stress effects may be dissociated, the latter considerably exceeding the stress period.

Loft *et al.*, (2007)¹² examined how cardiovascular and salivary cortisol responses varied in response to an acute challenge in medical students under exam stress versus those not under exam stress. One hundred and twenty-nine medical students were randomly assigned to undertake a CO₂ inhalation test either prior to an examination period (exam group) or during a regular academic period (non-exam group). Heart rate (HR) and blood pressure (BP) were measured for 5 min before and 5 min after the task, and salivary cortisol samples were collected 1 min before and 10 and 30 min after the CO₂ inhalation test. Participants also completed a questionnaire measuring self-reported perceived stress. The exam group exhibited significantly higher HR reactivity following the CO₂ inhalation test and slower systolic blood pressure (SBP) recovery compared with the non-exam group. The exam group also reported higher perceived stress and higher stress scores were related to higher HR reactivity following CO₂ inhalation. Female students across both groups exhibited significantly lower SBP reactivity compared with male students. Salivary cortisol levels were consistently lower in the exam group. These findings indicate that ongoing natural stress alters cortisol secretion and cardiovascular responses in the face of an acute stress challenge.

¹² P. Loft, M. G. Thomas, K. J. Petrie, R. J. Booth, J. Miles, and K. Vedhara, "Examination stress results in altered cardiovascular responses to acute challenge and lower cortisol." *Psychoneuroendocrinology*. 32, 4, 2007, pp.367-375.

Al-Ayadhi (2005)¹³ examined the effect of academic examination stress on activation of the hypothalamus-autonomic nervous system (HANS) and the hypothalamic-pituitary-adrenocortical (HPA) axis, through the measurements of changes in neuro-hormones during final exams as compared to the pre-exam baseline. Forty-eight first- and second-year female medical students participated. Plasma leptin, neuropeptide Y (NPY), nitrite, nitrate, adrenomedullin, cortisol and adrenocorticotrophic hormone (ACTH) were measured at baseline and during final examinations. The results revealed that plasma levels of cortisol, ACTH, NPY, adrenomedullin, nitrite and nitrate increased during times of academic stress as compared to baseline levels. However, only plasma leptin level was decreased during the academic stress as compared to baseline, probably through a negative feedback mechanism resulting from sympathetic stimulation. The results indicate that both the HANS and HPA are involved in this type of stress and both are activated at the same time. Academic stress induced significant neurohormonal changes. Leptin, NPY, nitrite, nitrate, adrenomedullin, cortisol and ACTH can be considered part of a complex mosaic model of the neuroendocrine system during academic stress.

Droogleever *et al.*, (2004)¹⁴ determined peripheral benzodiazepine receptor (PBR) density in blood platelets and plasma allopregnanolone concentration in humans following acute stress as represented by PhD examination. Fifteen healthy PhD students participated. Heart rate, blood pressure, plasma allopregnanolone, plasma cortisol, and PBR density were measured at different time points. Allopregnanolone and cortisol concentration and PBR density were significantly increased during examination. A positive correlation between allopregnanolone and PBR density was found.

¹³ L. Y. Al-Ayadhi, "Neurohormonal changes in medical students during academic stress." *Annals of Saudi Medicine*, 25, 1, 2005, pp.36-40.

¹⁴ H. A. Droogleever Fortuyn, F. van Broekhoven, P. N. Span, T. Backstrom, F. G. Zitman, and R. J. Verkes, "Effects of PhD examination stress on allopregnanolone and cortisol plasma levels and peripheral benzodiazepine receptor density." *Psychoneuroendocrinology*, 29, 10, 2004, pp.1341-1344.

Psychological stress factors can lead to changes in the immune system, the nervous system, and to psychosomatic diseases, besides releasing typical stress metabolites. This study on hand was to record the reliability of stress self assessment of students in various stress periods, and to be compared with the cortisol value of the saliva (Krahwinkle, Nastali, Azrak and Willershausen 2004)¹⁵. A total of 38 healthy students (18 women and 20 men), with an average age of 26.9 participated. The saliva of the participants was always tested between 9 AM and 10 AM, and always in various stress periods - during a typical semester internship, and immediately following the oral final examination. This was followed by a questionnaire concerning daily life styles (nutrition, part-time employment, sleeping pattern). The evaluation of the respective cortisol concentration of the total saliva resulted in a statistically high significant difference of values, relevant to stress levels ($p = 0.0001$). An average value for cortisol of 0.085 microg/dl total saliva was measured in the non-stress period, and in the stress period of 0.315 microg/dl total saliva. The comparison of the questionnaire evaluation to life styles did not show anything significant, the comparison to the cortisol concentration of the saliva showed significant deviations from the individual stress assessments by the participants. The results cover a significant correlation of particular stress factors to changes in cortisol values. It is important for dental therapy to use stress reducing measures, or reduce them as much as possible in order to avoid factors that pre-operatively can affect the patient in a stressful way.

Martinek *et al.*, (2003)¹⁶ investigated whether personality traits predict the cortisol response upon academic examinations. Nineteen male and female adolescent pupils (17 to 19 years) participated in the study. Two

¹⁵ T. Krahwinkle, S. Nastali, B. Azrak, and B. Willershausen, "The effect of examination stress conditions on the cortisol content of saliva - a study of students from clinical semesters." European Journal of Medical Research, 9, 5, 2004, pp.256-260.

¹⁶ L. Martinek, K. Oberascher-Holzinger, S. Weishuhn, W. Klimesch, and H. H. Kerschbaum, "Anticipated academic examinations induce distinct cortisol responses in adolescent pupils." Neuro Endocrinol Lett. 24, 6, 2003, pp.449-453.

anticipated, mandatory, routine written examinations were used as familiar stressful conditions, whereas an anticipated, mandatory oral examination in front of a board of known and unknown examiners was used as a novel stressful situation. Baseline, pre- and post examination salivary cortisol were quantified and correlated with psychometric measures, including self-estimated stress level, obtained from a five-point scale, and sensation seeking subscales according to Zuckerman. Salivary cortisol response, taken as an average of all subjects, showed a transient increase upon examinations. However, comparing individual cortisol responses revealed three distinct cortisol profiles, including a transient increase (Type 1), a transient decline (Type 2), or no response (Type 3). Type 1 predominates in examinations combined with novelty. A moderate negative association was noted between saliva cortisol concentrations on some sensation seeking subscales. Self-reported stress levels did not significantly correlate with salivary cortisol concentration. These findings show that upon academic examinations the cortisol response varies among subjects. A moderate negative association was unveiled by correlating individual cortisol responses with sensation seeking subscales.

Ng, Koh and Chia (2003)¹⁷ examined relation between examination stress, salivary cortisol, and academic performance. For this purpose immediately before and after participation in a written final examination, 11 graduate students rated their self-perceived stress and provided saliva samples for cortisol assay. Students rated stress higher before the examination, and these ratings were associated with increased salivary cortisol. Students who reported higher stress and had higher cortisol levels before the examination tended to have significantly lower examination scores.

¹⁷ V. Ng, D. Koh, and S. E. Chia, "Examination stress, salivary cortisol, and academic performance." *Psychological Reports*, 93,3Pt2, 2003, pp.1133-1144.

Vedhara *et al.*, (2000)¹⁸ conducted an investigation to explore the relationship between acute changes in cortisol and memory and attention in the context of an acute naturalistic stressor, namely, examination stress. Sixty students (36 male, 24 female) participated in an assessment of self-reported levels of stress, salivary cortisol, short term memory, selective and divided attention and auditory verbal working memory. Assessments were conducted during a non-exam and exam period. The results revealed that the exam period was associated with an increase in perceived levels of stress, but also a significant reduction in levels of salivary cortisol, compared with the non-exam period. This reduction in cortisol was associated with enhanced short-term memory (as measured by the total number of words recalled in a free recall task), impaired attention and an impairment in the primacy effect (a hippocampal-specific index of short term memory), but no significant effects on auditory verbal working memory. It was concluded that the results support the view that cortisol can modulate cognitive processes and that the effects of corticosteroids on cognitive function are selective.

McCann *et al.*, (1996)¹⁹ studied the effect of psychological stress on plasma lipids in 40 law students (20 men and 20 women). Plasma cholesterol, triglyceride, and apolipoprotein concentrations were examined at the beginning of the quarter and during the week before final examinations. Cortisol, blood pressure, and heart rate, and self-reports of stress and workloads were also measured to verify that examinations were associated with increased stress levels. Perceived stress, perceived workload, and cortisol increased before examinations. Low density lipoprotein cholesterol (LDL-C) increased 5.8 +/- 13.9 mg/dL, and apolipoprotein B (apo B) increased 2.9 +/- 4.0 mg/dL. High density lipoprotein cholesterol decreased in women only. These changes were not due to changes in dietary intake or indexes of

¹⁸ K. Vedhara, J. Hyde, I. D. Gilchrist, M. Tytherleigh, and S. Plummer, "Acute stress, memory, attention and cortisol." *Psychoneuroendocrinology*. 25, 6, 2000, pp.535-549.

¹⁹ B. S. McCann, G. A. Benjamin, C. W. Wilkinson, J. Carter, B. M. Retzlaff, J. Russo, and R. H. Knopp, "Variations in plasma lipid concentration during examination stress." *International Journal of Behavioral Medicine*, 3, 3, 1996, pp.251-265.

plasma volume. However, changes in cortisol and changes in LDL-C and apo B were associated, suggesting a neuroendocrine component to the effects. These results suggest that episodic, stressful situations may lead to potentially atherogenic changes in lipid and lipoprotein concentrations.

Malarkey *et al.*, (1995)²⁰ investigated the influence of a common stressful event, i.e., academic examinations, on the 24-h mean concentration of adrenocorticotrophic hormone (ACTH), cortisol, and/or beta-endorphin. In addition the effect of season on the endocrine response to this stressor was evaluated. The investigators studied medical students (n = 55), screened for a variety of health and life style factors, from three consecutive medical school classes 1 month before, during, and 2 weeks following examinations. Hourly blood samples were obtained from an indwelling catheter and two serum pools were made (0800-2200h = day and 2300-0700h = night). Examinations produced a significant ($p < .001$) increase in perceived stress scores. In addition, it was found a significant ($p < .001$) effect of examination stress on the increase in mean daytime but not nocturnal ACTH levels during autumn, but not during the spring. In contrast, the examination stress did not significantly affect day or night mean cortisol levels from baseline to examination week. Further the students were divided by whether their perceived stress scores increased during examination week and fell during recovery (Group 1) or whether their perceived stress scores did not follow the expected pattern (Group 2). It was found that in the Group 1 students who perceived the most stress, cortisol levels significantly increased ($p < .001$) from baseline to examination. Therefore, the nature of the stressor and the state of the responder were of equal importance in the observed cortisol response during examinations among these students. Further, academic stress had no significant effect on beta-endorphin levels. Finally, it was found that the mean day and night ACTH levels were higher ($p < .001$) in the spring

²⁰ W. B. Malarkey, D. K. Pearl, L. M. Demers, J. K. Kiecolt-Glaser, and R. Glaser, "Influence of academic stress and season on 24-hour mean concentrations of ACTH, cortisol, and beta-endorphin." *Psychoneuroendocrinology*. 20, 5, 1995, pp.499-508.

than in the fall; a seasonal influence on cortisol and beta-endorphin concentrations, however, was not observed. In summary, it was demonstrated that stress associated with the taking of examinations produces a dissociation among mean 24-h levels of ACTH, cortisol, and beta-endorphin. In addition, daytime cortisol levels increased during examinations only in the group of students whose perceived stress scores increased. Further, a seasonal influence on ACTH secretion was suggested by these results with higher levels observed in the spring than in the fall.

Tigranian *et al.*, (1980)²¹ measured the levels of several hormones (ACTH, GH, TSH, FSH, LH, parathyroid hormone--PTH, insulin, thyroxine--T4, triiodothyronine--T3, cortisol, testosterone, aldosterone, renin), catecholamines (epinephrine, norepinephrine, dopamin), prostaglandins (F1 alpha, F2 alpha, A + E), electrolytes (Na, K, Ca, Mg), cAMP and glucose in blood before and immediately after the examination in 15 male students aged 28 to 35 years. Simultaneously the blood pressure was measured and hemodynamic measures were registered with the aid of echocardiography. A remarkable increase of catecholamines, ACTH, renin, T3, PTH, cAMP, PG F1 alpha, PG F2 alpha and Ca was found before the examination together with the increase of blood pressure. After the examination the levels of catecholamines, renin, aldosterone, T3, PTH, GH, FSH, LH, testosterone, PG A + E, glucose and Ca were found to be increased, while these of insulin, Na, PG F1 alpha, PG F2 alpha were decreased. The decrease of blood pressure was also found.

Hulme, French and Agrawal (2011)²² compared the diurnal patterns of cortisol secretion of 15 medical students 2 weeks before a major written

²¹ R. A. Tigranian, L. L. Orloff, N. F. Kalita, N. A. Davydova, and E. A. Pavlova, "Changes of blood levels of several hormones, catecholamines, prostaglandins, electrolytes and cAMP in man during emotional stress." *Endocrinol Exp*, 14, 2, 1980, pp.101-112.

²² P. A. Hulme, J. A. French, and S. Agrawal, "Changes in diurnal salivary cortisol levels in response to an acute stressor in healthy young adults." *Journal of American Psychiatric Nurses Association*, 17, 5, 2011, pp.339-349.

examination (control phase) and 2 weeks later at the time of the examination (acute stress phase). During the acute stress phase, less cortisol was secreted over the course of the day, as demonstrated by a more prolonged and steeper decline in cortisol levels. In addition, higher cortisol levels were present in the evening. Despite these changes in the usual diurnal pattern, overall exposure to cortisol remained the same for both phases. The results of this study suggest that specific adaptations to the diurnal pattern of cortisol are made in the face of acute stress, important information for understanding cortisol regulation in health and illness.

Katsuura *et al.*, (2011)²³ conducted an investigation to identify circulating immune mediators reflecting anxiety and depressive mood in healthy young adults. Anxiety and depressive mood in 209 healthy medical students (125 males and 84 females, aged 20.7±2.7years (mean±SD)) were assessed by the Spielberger state-trait anxiety inventory (STAI) and the Zung self-rating depression scale (Zung-SDS), respectively. Cortisol and chromogranin A (CgA) levels in saliva were measured using enzyme immunoassay kits, and 50 different mediators in sera were measured by a multiplex-suspension array system. Forty-four mediators were measurable in sera, and each mediator showed substantial individual variations. After determining Pearson correlation coefficients, investigators selected candidate cytokines whose levels were associated with STAI-state (2 cytokines), STAI-trait (8 cytokines), or SDS scores (8 cytokines). The candidate cytokines plus interleukin (IL)-1, IL-6, tumor necrosis factor-, and macrophage migration inhibitory factor were then subjected to multiple regression analysis adjusted for gender, BMI, and salivary concentrations of cortisol and CgA. Vascular endothelial growth factor (VEGF) was independently and negatively associated with both trait anxiety ($p<0.05$) and depressive mood ($p<0.01$). IL-1 showed independently positive association with depressive mood ($p<0.05$).

²³ S. Katsuura, Y. Kamezaki, N. Yamagishi, Y. Kuwano, K. Nishida, K. Masuda, T. Tanahashi, T. Kawai, K. Arisawa, and K. Rokutan, "Circulating vascular endothelial growth factor is independently and negatively associated with trait anxiety and depressive mood in healthy Japanese university students." *International Journal of Psychophysiology*, 81, 1, 2011, pp.38-43.

Interactions between these two cytokines and gender or BMI were not observed. Besides IL-1 , circulating VEGF may be a potential biomarker for negative mood states in healthy young adults.

Pani *et al.*, (2011)²⁴ conducted a study to identify the perceived sources of stress in final-year dental students studying in a private dental school in Riyadh, Saudi Arabia, using a modified dental environmental stress (DES) scale and to correlate these findings, at various times in the semester, with the level of acute stress measured with salivary cortisol as a biomarker. A total of forty final-year students were administered a modified DES questionnaire consisting of twenty-five questions to determine the perceived causes of stress. Salivary cortisol levels during the first week of the semester, the final week of clinical training, and one hour before the final didactic examination were assessed. Baseline cortisol levels were significantly lower than the cortisol levels in the clinic, and both these values were significantly lower than the salivary cortisol levels before the examination ($p < 0.001$). Comparison of cortisol levels to the perceived sources of stress and demographic data collected showed that certain discrepancies may exist between the perceived and actual stress felt by dental students at different times in the academic semester.

Several studies have exhibited the psychological processes that are implied in the stress response and have shown, according to Selye's research, the participation of the hypothalamic-pituitary-adrenal axis and the major role of cortisol. The possible action of another adrenal steroid, dehydroepiandrosterone (DHEA), is increasingly documented. The beneficial effect of the latter and his antistress role would be related to an antagonistic action to that of cortisol. Therefore, the aim of this study conducted by

²⁴ S. C. Pani, A. M. Al Askar, S. I. Al Mohrij, and T. A. Al Ohali, "Evaluation of stress in final-year Saudi dental students using salivary cortisol as a biomarker." *Journal of Dental Education*, 75, 3, 2011, pp.377-384.

Boudarene, Legros, Timsit-Berthier (2002)²⁵ was, first to assess biological and psychological aspects of the stress response, then to define the relationships that exist between these two processes. 40 subjects (21 women) aged 42 +/- 12 years, who consulted within a clinic of stress (CITES Prevert, Liege, Belgium) were studied. They all felt stressed but, according to DSM IV, were without mental disorders and drug free when examined. Subjects were asked to accomplish simple cognitive tasks: 1 - to distinguish two different auditory stimulations. The first one was a high-pitched sound of 1 470 Hz, which was presented unfrequently (20%). The second one, a low frequency tone of 800 Hz, was presented more frequently (80%). The interval between both stimuli was 1 s. The subject had to press a button when the rare stimulus was recognized. 2 - to extinguish a light after a warning tone of 64 dB, 50 ms and 1 000 Hz. The light, which followed one second later the tone, consisted of a series of flashes of 18 c/s that the subject had to stop by pressing a button. The purpose of this second procedure was that the subject was warned and had to prepare and anticipate the most rapid response. After that, subjects were submitted to self-evaluation psychological tests. The impact of psychosocial factors was assessed by Amiel-Lebigre life events questionnaire. Personality features and emotional response (state anxiety, related to experimental situation) were assessed by Spielberger inventory (STAI: State and Trait Anxiety Inventory). Psychological tests are practised immediately after experimental situation. Cortisol and DHEAs (dehydroepiandrosterone sulfate) were measured in blood samples taken before (t1) and after (t2) the experimental test. Cortisol was measured by radio-immunology and expressed as ng/ml of plasma. DHEAs was measured by radio-immunoassay and expressed as g/liter of plasma. The majority of subjects displayed high scores of trait anxiety (37 subjects had a score >42) and life events impact (35 subjects had a score >200). These data confirmed that the subjects were fragile and were obviously stressed. In response to the cognitive tasks, that constituted for each subject a new event with which it

²⁵ M. Boudarene, J. J. Legros, and M. Timsit-Berthier, "Study of the stress response: role of anxiety, cortisol and DHEAs." *Encephale*, 28, 2, 2002, pp.139-146.

was necessary to cope, 25 subjects exhibited high level of state anxiety (score >42) and an increase of cortisol plasmatic concentrations occurred solely in 11 persons. Ten among them were in the group of subjects which displayed a score of state anxiety >42 ($p=0,0223$, Chi square). Base on these data three types of stress response were identified: 1 - the experimental situation was experienced without anxiety (psychological silence) and without any increase in cortisol level (biological silence). There was no stress and these subjects were, despite their vulnerability, close to a normal health state . 2 - high emotional reaction (high level of state anxiety) was observed. This response reveals a psychological vulnerability that can be considered as the expression of a consecutive psychological distress induced by a threatening experimental situation. There were no biological manifestations (biological silence). 3 - high state anxiety and increased plasma cortisol levels were observed. The corresponding subjects were obviously more vulnerable. These results propose that the emergence of state anxiety is the first stress response and the primary protest . Up to a certain level, a plateau level, anxiety remains stable. Then, nature of the stress response changes and takes a biological aspect. Increased of cortisol plasma levels, the secondary protest, is observed and gives evidence of an intensified and sustained stress response. Such a gradual phenomenon is particularly reported in elevated psychological distress which is associated with loss of control. It is important to note that identical scores of state anxiety (Mann Whitney test) were observed in anxious subjects with or without rise of plasma cortisol levels. DHEAs was also implied in the stress response. The enhancement of plasma levels of DHEAs were dependent on cortisol, as shown by the close correlation between both hormones ($r=0,433$, $p=0,0033$, Spearman test). The hypothesis of an antagonism between these two hormones is based on the fact that DHEAs opposes the action of cortisol and exerts a true anticortisol effect. This antagonism might be related to a competition in their synthesis and release by the adrenal gland. In the present case, high level of anxiety (state and trait) was associated with an increase of cortisol, while low level (of anxiety) was related to an exclusive rise of DHEAs. Intermediate anxious

score was observed in subjects who showed increases of both cortisol and DHEAs ($p=0,0225$, Kruskal Wallis test). Furthermore, a close relationship (negative correlation: Spearman test), was observed between increases in DHEAS and scores of state anxiety ($r=-0,382$, $p=0,06$) and trait anxiety ($r=-0,0097$, $p=0,527$). This means that the worriness and the underlying anxious ruminations and negative anticipations, which characterize trait anxiety, were less important in subjects who increased plasma DHEAs levels. In addition, emotional tension and uneasiness, which accompanies state anxiety, were also less marked. There are no studies reporting a relation between DHEA(s) and state or trait anxiety. Nevertheless, many authors have proposed a beneficial action of DHEA on the feeling of well-being. This beneficial role could be related to a double action of DHEA: a direct effect provided by its transformation into sexual hormones, an indirect one mediated by its competition with cortisol, of which the synthesis and consequently the activity decrease.

Hashmat, Amanullah and Aziz (2008)²⁶ assessed examination related anxiety among final professional medical students by VAS (Visual Analogue Scale) and determined the factors contributing to exam anxiety among final professional medical students. A cross sectional study using structured self-administered questionnaire was carried out over four weeks in Dow Medical College using sample size of 120 students. Duration of study was four weeks in May 2006. Survey questionnaire consisted of VAS to measure exam anxiety and seventeen questions regarding life style, study style, psychological problems, and examination system. A total of 120 students out of 200 (60%) filled in the questionnaire. There were 25.8% male and 74.2% female students. The average maximum Exam Anxiety marked on VAS was 64 ± 28 . Among different factors contributing to exam anxiety, extensive course loads (90.8%), lack of physical exercise (90%) and long duration of exams (77.5%) were the most important factors reported by the students.

²⁶ S. Hashmat, M. Hashmat, F. Amanullah, and S. Aziz, "Factors causing exam anxiety in medical students." *Journal of Pakistan Medical Association*, 58, 4, 2008, pp.167-170.

Most of the students had no knowledge of exam-taking and anxiety-reduction techniques and majority of those who knew these strategies did not implement them. This study indicates moderate level of exam anxiety based on a Visual Analogue Scale in students of a medical college and also highlights factors such as extensive course load, lack of exercise and long duration of exams which contribute to Exam Anxiety.

The purpose of this study conducted by Retegui (2006)²⁷ was to measure and compare medicine clerkship student SP versus MCQ examination anxiety levels and to determine if level affected test performance. The Spielberger test attitude inventory was used to measure anxiety in 150 students rotating through the clerkship. Students completed questionnaires after the MCQ and SP examinations. Mean examination scores and anxiety levels were compared. Based on questionnaire scores, students were divided into 3 groups: low, moderate, and high anxiety. The MCQ and SP examination scores were analyzed to determine if male/female anxiety-level affected test performance. There were no meaningful anxiety-level differences between the SP and MCQ examinations. An inverse relationship between anxiety level and test scores was not identified. Female students had higher anxiety levels but sex differences did not influence examination performance. Medicine clerkship student test performance is not affected by anxiety level. Implications of the findings for incorporating stress management training in medical school curricula and suggestions for future research are discussed.

Kidson and Hornblow (1982)²⁸ investigated Medical students' levels of anxiety under different conditions of stress, as well as the stability of anxiety ratings from one examination to another. After completing an end-of-term psychiatry examination, fourth-year medical students at Monash University

²⁷ J. A. Retegui, "Relationship between anxiety and standardized patient test performance in the medicine clerkship." *Journal of General Internal Medicine*, 21, 5, 2006, pp.415-418.

²⁸ M. Kidson, and A. Hornblow, "Examination anxiety in medical students: experiences with the visual analogue scale for anxiety." *Medical Education*, 16, 5, 1982, pp.247-250.

were asked to score the Visual Analogue Scale for Anxiety (VASA) for three situational cues; usual day-to-day anxiety, highest anxiety associated with major exams the previous year and anxiety experienced in the end-of-term examination just completed. Twenty-eight weeks later students rated their anxiety in a subsequent end-of-term psychiatry examination. Most students rated themselves toward the lower end of the VASA for day-to-day anxiety and as having significantly, though not markedly higher anxiety in the end-of-term psychiatry examinations. The previous year's examinations, marking the end of pre-clinical training, provoked extremely high anxiety for most students, who achieved academically despite this. Comparison of anxiety ratings for the two end-of-term examinations indicated that VASA ratings shifted substantially for half the class. This variation suggests that students' levels of anxiety are not stable and predictable from one examination to another. Examination anxiety should not be seen necessarily as a consistent response to a specific and recurring situation. It is postulated that a range of situational factors and personal pressures, operating at the time, may determine how much anxiety is experienced as a reaction to the examination.

This study carried out by Stewart *et al.*, (1999)²⁹ provides prospective, longitudinal data on the relationship between stress-related measures and academic performance during the first two years of medical school. First year medical students (n = 121) were surveyed prior to beginning classes (wave 1), and again 8 months later (wave 2). Personality variables predisposing to distress (optimism and trait anxiety), stress response (depression and state anxiety), and stress management strategies were assessed at wave 1 and wave 2. Pre-medical academic scores and grades at the end of five assessment periods over the course of the first 2 years of medical school were also obtained. As expected, pre-medical-school academic performance strongly predicted performance in medical school. Academic performance

²⁹ S. M. Stewart, T. H. Lam, C. L. Betson, C. M. Wong, and A. M. Wong, "A prospective analysis of stress and academic performance in the first two years of medical school." *Medical Education*, 33, 4, 1999, pp.243-250.

before and during medical school was negatively related to reported stress levels. On bivariate correlations, there were numerous significant relationships between stress reported at waves 1 and 2, and medical school academic performance assessed after these measures. In addition there were modest negative correlations between self-reported coping strategies of 'humour' and 'wishful thinking', and consequent academic performance. However, the predictive value of stress and its management on prospective academic performance was much decreased once pre-medical-school performance was statistically controlled.

Shukla *et al.*, (1993)³⁰ conducted a study on 40 male and 10 female students appearing for the 1st MBBS examination. Two readings of pulse rate, blood pressure and electro cardiogram were taken viz 6 months (control) and 10 minutes prior to the examination. A significant increase was seen in the pulse rate and blood pressure readings before the examination as compared to the control readings. However, no significant change was observed in electro cardiographic recordings.

Marazziti *et al.*, (2007)³¹ conducted an investigation to evaluate whether the condition of a pre-exam stress may or not modify resting lymphocyte subsets, as well as blood pressure and heart rate. About 22 medical residents of both sexes not suffering from any medical or psychiatric disorder were included in the study. Anxiety levels were measured by means of the Hamilton rating scale for anxiety (HRSA) and anxiety traits by means of the panic-agoraphobic spectrum self-report (PAS-SR) version and the obsessive-compulsive spectrum self-report (OBS-SR) version. The results showed that systolic blood pressure and heart rate increased significantly just

³⁰ N. Shukla, N. S. Verma, S. N. Tandon, D. N. Khanna, S. Tewari, U. S. Pandey, and S. K. Singh, "Examination stress in medical student: a study." *Indian Journal of Medical Science*, 47, 11, 1993 pp. 264-266.

³¹ D. Marazziti, F. Ambroggi, M. Abelli, E. Di Nasso, M. Catena, G. Massimetti, M. Carlini, and L. Dell'Osso, "Lymphocyte subsets, cardiovascular measures and anxiety state before and after a professional examination." *Stress*. 10, 1, 2007, pp.93-99.

before sitting an examination (t(1)) in all subjects, as compared with a calm situation (t(2)), in parallel with the increase in the HRSA total score, while no significant difference was observed in lymphocyte subsets at the two assessment times. However, men had a higher number of CD4+ cells than women at t(1) and t(2), while women showed a higher heart rate at t(1). In addition, significant correlations between CD4+ lymphocyte count and heart rate at t(1) or HRSA at t(2) were detected. These findings indicate that the acute stress determined by sitting for examination provokes changes in autonomic nervous system parameters, such as blood pressure and heart rate, as well as in the subjective feeling of anxiety, as shown by the increased HRSA total scores, which were not paralleled by modifications of lymphocyte subsets. However, individual differences, related to both sex and personality traits yet to be identified, seem to have an impact in shaping the stress response.

2.2 Studies on Role of Yoga in Stress

Academic performance is concerned with the quantity and quality of learning attained in a subject or group of subjects after a long period of instruction. Excessive stress hampers students' performance. Improvement in academic performance and alertness has been reported in several yogic studies. Therefore, the main objective of this study conducted by Kauts and Sharma (2009)³² was to assess the effect of yoga on academic performance in relation to stress. The study started with 800 adolescent students; 159 high-stress students and 142 low-stress students were selected on the basis of scores obtained through Stress Battery. Experimental group and control group were given pre test in three subjects, i.e., Mathematics, Science, and Social Studies. A yoga module consisting of yoga asanas, pranayama, meditation, and a value orientation program was administered on experimental group for

³² A. Kauts, and N. Sharma, "Effect of yoga on academic performance in relation to stress." *International Journal of Yoga*, 2, 1, 2009, pp.39-43.

7 weeks. The experimental and control groups were post-tested for their performance on the three subjects mentioned above. The results show that the students, who practiced yoga performed better in academics. The study further shows that low-stress students performed better than high-stress students, meaning thereby that stress affects the students' performance.

Harinath *et al.*, (2004)³³ evaluated effects of Hatha yoga and Omkar meditation on cardiorespiratory performance, psychologic profile, and melatonin secretion. Thirty healthy men in the age group of 25-35 years volunteered for the study. They were randomly divided in two groups of 15 each. Group 1 subjects served as controls and performed body flexibility exercises for 40 minutes and slow running for 20 minutes during morning hours and played games for 60 minutes during evening hours daily for 3 months. Group 2 subjects practiced selected yogic asanas (postures) for 45 minutes and pranayama for 15 minutes during the morning, whereas during the evening hours these subjects performed preparatory yogic postures for 15 minutes, pranayama for 15 minutes, and meditation for 30 minutes daily, for 3 months. Orthostatic tolerance, heart rate, blood pressure, respiratory rate, dynamic lung function (such as forced vital capacity, forced expiratory volume in 1 second, forced expiratory volume percentage, peak expiratory flow rate, and maximum voluntary ventilation), and psychologic profile were measured before and after 3 months of yogic practices. Serial blood samples were drawn at various time intervals to study effects of these yogic practices and Omkar meditation on melatonin levels. The results shows that Yogic practices for 3 months resulted in an improvement in cardiorespiratory performance and psychologic profile. The plasma melatonin also showed an increase after three months of yogic practices. The systolic blood pressure, diastolic blood pressure, mean arterial pressure, and orthostatic tolerance did not show any significant correlation with plasma melatonin. However, the maximum night

³³ K. Harinath, A. S. Malhotra, K. Pal, R. Prasad, R. Kumar, T. C. Kain, L. Rai, and R. C. Sawhney, "Effects of Hatha yoga and Omkar meditation on cardiorespiratory performance, psychologic profile, and melatonin secretion." *Journal of Alternative and Complementary Medicine*, 10, 2, 2004, pp.261-268.

time melatonin levels in yoga group showed a significant correlation ($r = 0.71$, $p < 0.05$) with well-being score. These observations suggest that yogic practices can be used as psychophysiological stimuli to increase endogenous secretion of melatonin, which, in turn, might be responsible for improved sense of well-being.

Ray *et al.*, (2001)³⁴ conducted a study to observe any beneficial effect of yogic practices during training period on the young trainees. 54 trainees of 20-25 years age group were divided randomly in two groups i.e. yoga and control group. Yoga group (23 males and 5 females) was administered yogic practices for the first five months of the course while control group (21 males and 5 females) did not perform yogic exercises during this period. From the 6th to 10th month of training both the groups performed the yogic practices. Physiological parameters like heart rate, blood pressure, oral temperature, skin temperature in resting condition, responses to maximal and submaximal exercise, body flexibility were recorded. Psychological parameters like personality, learning, arithmetic and psychomotor ability, mental well being were also recorded. Various parameters were taken before and during the 5th and 10th month of training period. Initially there was relatively higher sympathetic activity in both the groups due to the new work/training environment but gradually it subsided. Later on at the 5th and 10th month, yoga group had relatively lower sympathetic activity than the control group. There was improvement in performance at submaximal level of exercise and in anaerobic threshold in the yoga group. Shoulder, hip, trunk and neck flexibility improved in the yoga group. There was improvement in various psychological parameters like reduction in anxiety and depression and a better mental function after yogic practices.

³⁴ U. S. Ray, S. Mukhopadhyaya, S. S. Purkayastha, V. Asnani, O. S. Tomer, R. Prashad, L. Thakur, and W. Selvamurthy, "Effect of yogic exercises on physical and mental health of young fellowship course trainees." *Indian Journal of Physiology and Pharmacology*, 45, 1, 2001, pp.37-53.

A student under optimal stress does bring out his or her best, However extremes of stress can result in stress induced disorders and deteriorating performance. Hence, Malathi and Damodaran (1999)³⁵ conducted a study in first MBBS students (n = 50) to determine the benefit if any of yogic practices on anxiety status during routine activities and prior to examination. Feedback scores were assessed to determine how the students had benefited from the practices. Anxiety status as assessed by Spillberger's anxiety scale showed a statistically significant reduction following practice. In addition the anxiety score which rose prior to exams showed a statistically significant reduction on the day of exam after practice. These results point to the beneficial role of yoga in not only causing reduction in basal anxiety level but also attenuating the increase in anxiety score in stressful state such as exams. The results of the exam indicated a statistically significant reduction in number of failures in yoga group as compared to the control group. The improvement in various parameters such as better sense of well being, feeling of relaxation, improved concentration, self confidence, improved efficiency, good interpersonal relationship, increased attentiveness, lowered irritability levels, and an optimistic outlook in life were some of the beneficial effects enjoyed by the yoga group indicated by feedback score.

Smith, Hancock, Blake-Mortimer and Eckert (2007)³⁶ compared yoga and relaxation as treatment modalities at 10 and 16 weeks from study baseline to determine if either of modality reduces subject stress, anxiety, blood pressure and improve quality of life. One hundred and thirty-one subjects with mild to moderate levels of stress were recruited from the community in South Australia. The subjects were given ten weekly 1- h sessions of relaxation or hatha yoga. Changes in the State Trait Personality Inventory sub-scale anxiety, General Health Questionnaire and the Short

³⁵ A. Malathi, and A. Damodaran, "Stress due to exams in medical students--role of yoga." Indian Journal of Physiology and Pharmacology, 43, 2, 1999, pp.218-224.

³⁶ C. Smith, H. Hancock, J. Blake-Mortimer, and K. Eckert, "A randomised comparative trial of yoga and relaxation to reduce stress and anxiety." Complementary Therapies in Medicine, 15, 2, 2007, pp.77-83.

Form-36 were recorded. Following the 10 week intervention stress, anxiety and quality of life scores improved over time. Yoga was found to be as effective as relaxation in reducing stress, anxiety and improving health status on seven domains of the SF-36. Yoga was more effective than relaxation in improving mental health. At the end of the 6 week follow-up period there were no differences between groups in levels of stress, anxiety and on five domains of the SF-36. Vitality, social function and mental health scores on the SF-36 were higher in the relaxation group during the follow-up period. This study concludes that Yoga appears to provide a comparable improvement in stress, anxiety and health status compared to relaxation.

Simard and Henry (2009)³⁷ demonstrated the impact of a brief structured yoga intervention on medical students. Fourteen first-year medical students participated in a 16-week yoga intervention pilot study. Students completed questionnaires at baseline, mid-intervention and end of the study. The students reported improvements in overall health, perceived stress and depressive symptoms following the intervention. A yoga intervention may be effective in decreasing stress and improving general well-being in medical students.

Yoga and meditation can alleviate stress, anxiety, mood disturbance, and musculoskeletal problems, and can enhance cognitive and physical performance. Professional musicians experience high levels of stress, performance anxiety, and debilitating performance-related musculoskeletal disorders (PRMDs). The goal of this controlled study conducted by Khalsa *et al.*, (2009)³⁸ was to evaluate the benefits of yoga and meditation for musicians. Young adult professional musicians who volunteered to participate in a 2-month program of yoga and meditation were randomized to a yoga

³⁷ A. A. Simard, and M. Henry, "Impact of a short yoga intervention on medical students' health: a pilot study." *Medical Teacher*, 31, 10, 2009, pp.950-952.

³⁸ S. B. Khalsa, S. M. Shorter, S. Cope, G. Wyshak, and E. Sklar, "Yoga ameliorates performance anxiety and mood disturbance in young professional musicians." *Applied Psychophysiology and Biofeedback*, 34, 4, 2009, pp.279-289.

lifestyle intervention group (n = 15) or to a group practicing yoga and meditation only (n = 15). Additional musicians were recruited to a no-practice control group (n = 15). Both yoga groups attended three Kripalu Yoga or meditation classes each week. The yoga lifestyle group also experienced weekly group practice and discussion sessions as part of their more immersive treatment. All participants completed baseline and end-program self-report questionnaires that evaluated music performance anxiety, mood, PRMDs, perceived stress, and sleep quality; many participants later completed a 1-year follow up assessment using the same questionnaires. Both yoga groups showed a trend towards less music performance anxiety and significantly less general anxiety/tension, depression, and anger at end-program relative to controls, but showed no changes in PRMDs, stress, or sleep. Similar results in the two yoga groups, despite psychosocial differences in their interventions, suggest that the yoga and meditation techniques themselves may have mediated the improvements. These results suggest that yoga and meditation techniques can reduce performance anxiety and mood disturbance in young professional musicians.

Yoga techniques practiced for varying durations have been shown to reduce state anxiety. In this study, Telles, Gaur and Balkrishna (2009)³⁹ recruited 300 naive-to-yoga persons of both sexes who were attending a yoga therapy center in north India for stress relief as day visitors and were not residing at the center. They were assigned to two groups, yoga practice and yoga theory, and their state anxiety was assessed before and after a 2-hr. yoga session. A significant reduction in scores on state anxiety was found in the yoga practice group (14.7% decrease), as well as in the yoga theory group (3.4% decrease). The difference in scores following the sessions was statistically significant. Hence, yoga practice as well as learning about theoretical aspects of yoga appear to reduce state anxiety, with a greater reduction following yoga practice.

³⁹ S. Telles, V. Gaur, and A. Balkrishna, "Effect of a yoga practice session and a yoga theory session on state anxiety." *Perceptual Motor Skills*, 109, 3, 2009, pp.924-930.

The inability to cope successfully with the enormous stress of medical education may lead to a cascade of consequences at both a personal and professional level. Shapiro, Schwartz and Bonner (1998)⁴⁰ examined the short-term effects of an 8-week meditation-based stress reduction intervention on premedical and medical students using a well-controlled statistical design. Findings indicate that participation in the intervention can effectively (1) reduce self-reported state and trait anxiety, (2) reduce reports of overall psychological distress including depression, (3) increase scores on overall empathy levels, and (4) increase scores on a measure of spiritual experiences assessed at termination of intervention. These results (5) replicated in the wait-list control group, (6) held across different experiments, and (7) were observed during the exam period.

McComb, Tacon, Randolph and Caldera (2004)⁴¹ conducted a study with the objective to examine the effects of an 8-week mindfulness-based stress-reduction program on the resting levels of stress hormones, physical functioning, and submaximal exercise responses in women with heart disease. Random selection with the numbers 1 and 2 were used to assign 18 women (60 +/-6.3 years old) with documented histories of heart disease to a treatment group (n = 9) or a control group (n = 9). Spielberger's state anxiety scores for the treatment (M = 37.88; standard deviation (SD) = 10.91) and control group (M = 43.22; SD = 12.26) were not significantly different prior to the start of the study. However, their scores fell in the upper percentile rank for normal adults in their age category. The intervention was provided one night each week for 2 hours over a period of 8 weeks. The intervention included didactic, inductive, and experiential modes of learning regarding stress responses and mindfulness skill-development training. Pre-post test

⁴⁰ S. L. Shapiro, G. E. Schwartz, and G. Bonner, "Effects of mindfulness-based stress reduction on medical and premedical students." *Journal of Behavioral Medicine*, 21, 6, 1998, pp.581-599.

⁴¹ J. J. Robert McComb, A. Tacon, P. Randolph, and Y. Caldera, "A pilot study to examine the effects of a mindfulness-based stress-reduction and relaxation program on levels of stress hormones, physical functioning, and submaximal exercise responses." *Journal of Alternative and Complementary Medicine*, 10, 5, 2004, pp.819-827.

hormonal measurements and physical function were analyzed using a 2 (group) by 2 (time) analysis of variance (ANOVA) with repeated measures following the 8-week program. Submaximal exercise responses were also compared between the treatment group and the control group following the 8-week program. A 2 (group) by 3 (time) ANOVA with repeated measures was used to analyze the data. Weekly meetings were held on a university medical school campus. Submaximal exercise responses were recorded while participants cycled on a stationary bike in an applied physiology laboratory following the 8-week program. There were no significant main effects or interaction for the resting levels of stress hormones or physical functioning. There were no significant interactions for the submaximal exercise responses, however, there were significant main effects between groups for ventilation [$F(2,32) = 7.65, p < .01, f = 0.8$], and between group [$F(1,16) = 8.84, p < .01, f = 0.8$] and time [$F(2,32) = 10.42, p < .01, f = 0.9$], for breathing frequency. While the 8-week stress reduction program for women with heart disease did not show significant interactions between groups for resting levels of stress hormones, physical functioning, or submaximal exercise responses, there was a significant difference in breathing patterns between the 2 groups during exercise following the mindfulness-based stress-reduction program. There was also a trend for change in the intervention group in the resting levels of cortisol and physical function scores that was not seen in the control group. Future studies could use the effect size generated from this pilot study to calculate the number of subjects needed for adequate power to detect significant differences between groups.

Noggle, Steiner, Minami and Khalsa (2012)⁴² carried a research study to test feasibility of yoga within a high school curriculum and to evaluate preventive efficacy for psychosocial well-being. Grade 11 or 12 students (N = 51) who registered for physical education (PE) were cluster-randomized by

⁴² J. J. Noggle, N. J. Steiner, T. Minami, and S. B. Khalsa, "Benefits of yoga for psychosocial well-being in a US high school curriculum: a preliminary randomized controlled trial." *Journal of Developmental and Behavioral Pediatrics*, 33, 3, 2012, pp.193-201.

class 2:1 yoga: PE-as-usual. A Kripalu-based yoga program of physical postures, breathing exercises, relaxation, and meditation was taught 2 to 3 times a week for 10 weeks. Self-report questionnaires were administered to students 1 week before and after. Primary outcome measures of psychosocial well-being were Profile of Mood States-Short Form and Positive and Negative Affect Schedule for Children. Additional measures of psychosocial well-being included Perceived Stress Scale and Inventory of Positive Psychological Attitudes. Secondary measures of self-regulatory skills included Resilience Scale, State Trait Anger Expression Inventory-2™, and Child Acceptance Mindfulness Measure. To assess feasibility, yoga students completed a program evaluation. Analyses of covariance were conducted between groups with baseline as the covariate. Although PE-as-usual students showed decreases in primary outcomes, yoga students maintained or improved. Total mood disturbance improved in yoga students and worsened in controls ($p = .015$), as did Profile of Mood States-Short Form (POMS-SF) Tension-Anxiety subscale ($p = .002$). Although positive affect remained unchanged in both, negative affect significantly worsened in controls while improving in yoga students ($p = .006$). Secondary outcomes were not significant. Students rated yoga fairly high, despite moderate attendance. Implementation was feasible and students generally found it beneficial. Although not causal due to small, uneven sample size, this preliminary study suggests preventive benefits in psychosocial well-being from Kripalu yoga during high school PE. These results are consistent with previously published studies of yoga in school settings.

Fibromyalgia (FM) is a chronic condition characterized by widespread musculoskeletal pain, fatigue, depression, and hypocortisolism. This pilot study conducted by Curtis, Osadchuk and Katz (2011)⁴³ used a time series design to evaluate pain, psychological variables, mindfulness, and cortisol in

⁴³ Kathryn. Curtis, Anna. Osadchuk, and Joel. Katz, "An eight-week yoga intervention is associated with improvements in pain, psychological functioning and mindfulness, and changes in cortisol levels in women with fibromyalgia." *Journal of Pain Research*, 4, 2011, pp.189–201.

women with FM before and after a yoga intervention. Participants (n = 22) were recruited from the community to participate in a 75 minute yoga class twice weekly for 8 weeks. Questionnaires concerning pain (intensity, unpleasantness, quality, sum of local areas of pain, catastrophizing, acceptance, disability), anxiety, depression, and mindfulness were administered pre-, mid- and post-intervention. Salivary cortisol samples were collected three times a day for each of two days, pre- and post-intervention. Repeated measures analysis of variance (ANOVA) revealed that mean \pm standard deviation (SD) scores improved significantly ($p < 0.05$) from pre- to post-intervention for continuous pain (pre: 5.18 ± 1.72 ; post: 4.44 ± 2.03), pain catastrophizing (pre: 25.33 ± 14.77 ; post: 20.40 ± 17.01), pain acceptance (pre: 60.47 ± 23.43 ; post: 65.50 ± 22.93), and mindfulness (pre: 120.21 ± 21.80 ; post: 130.63 ± 20.82). Intention-to-treat analysis showed that median AUC for post-intervention cortisol (263.69) was significantly higher ($p < 0.05$) than median AUC for pre-intervention levels (189.46). Mediation analysis revealed that mid-intervention mindfulness scores significantly ($p < 0.05$) mediated the relationship between pre- and post-intervention pain catastrophizing scores. The results suggest that a yoga intervention may reduce pain and catastrophizing, increase acceptance and mindfulness, and alter total cortisol levels in women with FM. The changes in mindfulness and cortisol levels may provide preliminary evidence for mechanisms of a yoga program for women with FM.

Stress produces definable mental and physiological reactions in the body. Mild stress is beneficial in cognitive tasks and performance but persistently high stress may lead to neuropsychiatric illnesses like anxiety and depression. Examinations act as stressor and activate hypothalamic-pituitary adrenal axis causing an increase in cortisol level, which is reflected in saliva. This study by Singh *et al.*, (2012)⁴⁴ was conducted on 35 medical students.

⁴⁴ Ruchi. Singh, Manish. Goyal, Sunita Tiwari, Archana. Ghildiyal, Shankar M. Nattu and Shobha. Das, "Effect of examination stress on mood, performance and cortisol levels in medical students." *Indian Journal of Physiology and Pharmacology*, 56, 1, 2012, pp.48–55.

Their mood parameters were assessed, using Depression Anxiety Stress Scale (DASS) scoring, and salivary cortisol levels using quantitative ELISA. Subjects were evaluated for mood parameters two times, one during relaxed state (with no examinations in preceding 2 weeks and in coming 2 weeks) and another during stressed state (on the day of viva voce examination). The levels of mood parameters and salivary cortisol were significantly raised during examination stress. The changes in stress level significantly correlated with change in levels of anxiety and salivary cortisol though there was no significant effect on the performance. Males and females showed similar changes in mood parameters. This study suggests that as examinations act as unavoidable stressors, the medical educators as well as students should be made aware of the negative consequences of stress faced during medical training. Efficient relaxation program as well as counseling services should be provided to stressed students so that they are able to cope better with examination stress.

Carlson, Speca, Patel and Goodey (2004)⁴⁵ investigated the relationships between a mindfulness-based stress reduction meditation program for early stage breast and prostate cancer patients and quality of life, mood states, stress symptoms, and levels of cortisol, dehydroepiandrosterone-sulfate (DHEAS) and melatonin. Fifty-nine patients with breast cancer and 10 with prostate cancer enrolled in an eight-week Mindfulness-Based Stress Reduction (MBSR) program that incorporated relaxation, meditation, gentle yoga, and daily home practice. Demographic and health behavior variables, quality of life, mood, stress, and the hormone measures of salivary cortisol (assessed three times/day), plasma DHEAS, and salivary melatonin were assessed pre- and post-intervention. Fifty-eight and 42 patients were assessed pre- and post-intervention, respectively. Significant improvements were seen in overall quality of life, symptoms of

⁴⁵ L. E. Carlson, M. Speca, K. D. Patel, and E. Goodey, "Mindfulness-based stress reduction in relation to quality of life, mood, symptoms of stress and levels of cortisol, dehydroepiandrosterone sulfate (DHEAS) and melatonin in breast and prostate cancer outpatients." *Psychoneuroendocrinology*. 29, 4, 2004, pp.448-474.

stress, and sleep quality, but these improvements were not significantly correlated with the degree of program attendance or minutes of home practice. No significant improvements were seen in mood disturbance. Improvements in quality of life were associated with decreases in afternoon cortisol levels, but not with morning or evening levels. Changes in stress symptoms or mood were not related to changes in hormone levels. Approximately 40% of the sample demonstrated abnormal cortisol secretion patterns both pre- and post-intervention, but within that group patterns shifted from "inverted-V-shaped" patterns towards more "V-shaped" patterns of secretion. No overall changes in DHEAS or melatonin were found, but nonsignificant shifts in DHEAS patterns were consistent with healthier profiles for both men and women. The findings suggests that MBSR program enrollment was associated with enhanced quality of life and decreased stress symptoms in breast and prostate cancer patients, and resulted in possibly beneficial changes in hypothalamic-pituitary-adrenal (HPA) axis functioning.

The objective of this pilot study conducted by Smith *et al.*, (2008)⁴⁶ was to compare the effects of two mind-body interventions: mindfulness-based stress reduction (MBSR) and cognitive-behavioral stress reduction (CBSR). Fifty (50) subjects were recruited from the community and took part in MBSR (n = 36) and CBSR (n = 14) courses. Participants self-selected into MBSR or CBSR courses taught at different times. There were no initial differences between the MBSR and CBSR subjects on demographics, including age, gender, education, and income. MBSR was an 8-week course using meditation, gentle yoga, and body scanning exercises to increase mindfulness. CBSR was an 8-week course using cognitive and behavioral techniques to change thinking and reduce distress. Perceived stress, depression, psychological well-being, neuroticism, binge eating, energy, pain, and mindfulness were assessed before and after each course. Pre-post

⁴⁶ B. W. Smith, B. M. Shelley, J. Dalen, K. Wiggins, E. Tooley, and J. Bernard, "A pilot study comparing the effects of mindfulness-based and cognitive-behavioral stress reduction." Journal of Alternative and Complementary Medicine, 14, 3, 2008, pp.251-258.

scores for each intervention were compared by using paired t tests. Pre-post scores across interventions were compared by using a general linear model with repeated measures. The results revealed that MBSR subjects improved on all eight outcomes, with all of the differences being significant. CBSR subjects improved on six of eight outcomes, with significant improvements on well-being, perceived stress, and depression. Multivariate analyses showed that the MBSR subjects had better outcomes across all variables, when compared with the CBSR subjects. Univariate analyses showed that MBSR subjects had better outcomes with regard to mindfulness, energy, pain, and a trend for binge eating. While MBSR and CBSR may both be effective in reducing perceived stress and depression, MBSR may be more effective in increasing mindfulness and energy and reducing pain.

The aim of the randomized controlled trial conducted by Carson *et al.*, (2010)⁴⁷ was to evaluate the effects of a comprehensive yoga intervention on fibromyalgia symptoms and coping. A sample of 53 female FM patients were randomized to the 8-week Yoga of Awareness program (gentle poses, meditation, breathing exercises, yoga-based coping instructions, group discussions) or to wait-listed standard care. Data were analyzed by intention to treat. At post-treatment, women assigned to the yoga program showed significantly greater improvements on standardized measures of FM symptoms and functioning, including pain, fatigue, and mood, and in pain catastrophizing, acceptance, and other coping strategies. This pilot study provides promising support for the potential benefits of a yoga program for women with FM.

Shelov, Suchday and Friedberg (2009)⁴⁸ examined whether yoga would increase levels of mindfulness in a healthy population. Forty-six

⁴⁷ J. W. Carson, K. M. Carson, K. D. Jones, R. M. Bennett, C. L. Wright, and S. D. Mist, "A pilot randomized controlled trial of the Yoga of Awareness program in the management of fibromyalgia." *Pain*, 151, 2, 2010, pp.530-539.

⁴⁸ D. V. Shelov, S. Suchday, and J. P. Friedberg, "A pilot study measuring the impact of yoga on the trait of mindfulness." *Behavioral Cognition Psychotherapy*, 37, 5, 2009, pp.595-598.

participants were randomly assigned to an 8-week yoga intervention group or a wait-list control group. Mindfulness was assessed pre and post yoga, using the Freiburg Mindfulness Inventory (FMI). Results indicate that the yoga group experienced a significant increase in Overall mindfulness, and in three mindfulness subscales; Attention to the present moment, Accepting and open attitudes toward experience, and Insightful understanding ($p < .01$). The control group experienced a significant increase in overall mindfulness ($p < .02$) and insightful understanding ($p < .01$). Findings suggest that a yoga intervention may be a viable method for increasing levels of trait mindfulness in a healthy population, potentially implicating yoga as a preventive method for the later development of negative emotional mood states (i.e. anxiety and depression). The control group also experienced moderate elevations of mindfulness at the second assessment.

Woolery, Myers, Sternlieb and Zeltzer (2004)⁴⁹ examined the effects of a short-term Iyengar yoga course on mood in mildly depressed young adults. Young adults pre-screened for mild levels of depression were randomly assigned to a yoga course or wait-list control group. Twenty-eight volunteers ages 18 to 29. At intake, all participants were experiencing mild levels of depression, but had received no current psychiatric diagnoses or treatments. None had significant yoga experience. Subjects in the yoga group attended two 1-hour Iyengar yoga classes each week for 5 consecutive weeks. The classes emphasized yoga postures thought to alleviate depression, particularly back bends, standing poses, and inversions. Beck Depression Inventory, State-Trait Anxiety Inventory, Profile of Mood States, morning cortisol levels were assessed. Subjects who participated in the yoga course demonstrated significant decreases in self-reported symptoms of depression and trait anxiety. These effects emerged by the middle of the yoga course and were maintained by the end. Changes also were observed in acute mood,

⁴⁹ A. Woolery, H. Myers, B. Sternlieb, and L. Zeltzer, "A yoga intervention for young adults with elevated symptoms of depression." *Alternative Therapies in Health and Medicine*, 10, 2, 2004, pp.60-63.

with subjects reporting decreased levels of negative mood and fatigue following yoga classes. Finally, there was a trend for higher morning cortisol levels in the yoga group by the end of the yoga course, compared to controls. These findings provide suggestive evidence of the utility of yoga asanas in improving mood and support the need for future studies with larger samples and more complex study designs to more fully evaluate the effects of yoga on mood disturbances.

Michalsen *et al.*, (2005)⁵⁰ evaluated the potential effects of Iyengar Hatha yoga on perceived stress and associated psychological outcomes in mentally distressed women. A controlled prospective non-randomized study was conducted in 24 self-referred female subjects (mean age 37.9+/-7.3 years) who perceived themselves as emotionally distressed. Subjects were offered participation in one of two subsequent 3-months yoga programs. Group 1 (n=16) participated in the first class, group 2 (n=8) served as a waiting list control. During the yoga course, subjects attended two-weekly 90-min Iyengar yoga classes. Outcome was assessed on entry and after 3 months by Cohen Perceived Stress Scale, State-Trait Anxiety Inventory, Profile of Mood States, CESD-Depression Scale, Bf-S/Bf-S' Well-Being Scales, Freiburg Complaint List and ratings of physical well-being. Salivary cortisol levels were measured before and after an evening yoga class in a second sample. Compared to waiting-list, women who participated in the yoga-training demonstrated pronounced and significant improvements in perceived stress ($P<0.02$), State and Trait Anxiety ($P<0.02$ and $P<0.01$, respectively), well-being ($P<0.01$), vigor ($P<0.02$), fatigue ($P<0.02$) and depression ($P<0.05$). Physical well-being also increased ($P<0.01$), and those subjects suffering from headache or back pain reported marked pain relief. Salivary cortisol decreased significantly after participation in a yoga class ($P<0.05$). The results suggest that women suffering from mental distress

⁵⁰ A. Michalsen, P. Grossman, A. Acil, J. Langhorst, R. Ludtke, T. Esch, G. B. Stefano, and G. J. Dobos, "Rapid stress reduction and anxiolysis among distressed women as a consequence of a three-month intensive yoga program." *Medical Science Monitor*, 11, 12, 2005, pp.555-561.

participating in a 3-month Iyengar yoga class show significant improvements on measures of stress and psychological outcomes.

Bowden, Gaudry, An, and Gruzelier (2012)⁵¹ compared the effects of Brain Wave Vibration (BWV) training, which involves rhythmic yoga-like meditative exercises, with Iyengar yoga and Mindfulness. Iyengar provided a contrast for the physical components and mindfulness for the "mental" components of BWV. 35 healthy adults completed 10 75-minute classes of BWV, Iyengar, or Mindfulness over five weeks. Participants were assessed at pre- and post intervention for mood, sleep, mindfulness, absorption, health, memory, and salivary cortisol. Better overall mood and vitality followed both BWV and Iyengar training, while the BWV group alone had improved depression and sleep latency. Mindfulness produced a comparatively greater increase in absorption. All interventions improved stress and mindfulness, while no changes occurred in health, memory, or salivary cortisol. In conclusion, increased well-being followed training in all three practices, increased absorption was specific to Mindfulness, while BWV was unique in its benefits to depression and sleep latency, warranting further research.

To address the mechanisms underlying hatha yoga's potential stress-reduction benefits, Kiecolt-Glaser, Christian, Preston and Houts (2010)⁵² compared inflammatory and endocrine responses of novice and expert yoga practitioners before, during, and after a restorative hatha yoga session, as well as in two control conditions. Stressors before each of the three conditions provided data on the extent to which yoga speeded an individual's physiological recovery. 50 healthy women (mean age=41.32, range=30–65), 25 novices and 25 experts, were exposed to each of the conditions (yoga, movement control, and passive-video control) during three separate visits.

⁵¹ D. Bowden, C. Gaudry, S. C. An, and J. Gruzelier, "A comparative randomised controlled trial of the effects of brain wave vibration training, Iyengar yoga, and mindfulness on mood, well-being, and salivary cortisol." *Evidence Based Complementary and Alternative Medicine*, 2012, 234713.

⁵² K. Janice. Kiecolt-Glaser, Lisa. Christian, Heather. Preston, and Carrie. R. Houts, "Stress, inflammation, and yoga practice." *Psychosomatic Medicine*, 72, 2, 2010, p. 113.

Results indicate that the yoga session boosted participants' positive affect compared to the control conditions, but no overall differences in inflammatory or endocrine responses were unique to the yoga session. Importantly, even though novices and experts did not differ on key dimensions including age, abdominal adiposity, and cardiorespiratory fitness, novices' serum IL-6 levels were 41% higher than those of experts across sessions, and the odds of a novice having detectable CRP were 4.75 times as high as that of an expert. Differences in stress responses between experts and novices provided one plausible mechanism for their divergent serum IL-6 data; experts produced less LPS-stimulated IL-6 in response to the stressor than novices, and IL-6 promotes CRP production. The findings suggest that the ability to minimize inflammatory responses to stressful encounters influences the burden that stressors place on an individual. If yoga dampens or limits stress-related changes, then regular practice could have substantial health benefits.

Gopal *et al.*, (2011)⁵³ conducted an investigation to evaluate the impact of stress on psychological, physiological parameters, and immune system during medical term academic examination and the effect of yoga practices on the same. The study was carried out on sixty first-year MBBS students randomly assigned to yoga group and control group (30 each). The yoga group underwent integrated yoga practices for 35 minutes daily in the presence of trained yoga teacher for 12 weeks. Control group did not undergo any kind of yoga practice or stress management. Physiological parameters like heart rate, respiratory rate, and blood pressure were measured. Global Assessment of Recent Stress Scale and Spielbergers State Anxiety score were assessed at baseline and during the examination. Serum cortisol levels, IL-4, and IFN- levels were determined by enzyme-linked immunosorbent assay technique. In the yoga group, no significant difference was observed in physiological parameters during the examination stress, whereas in the

⁵³ A. Gopal, S. Mondal, A. Gandhi, S. Arora, and J. Bhattacharjee, "Effect of integrated yoga practices on immune responses in examination stress - A preliminary study." *International Journal of Yoga*, 4, 1, 2011, pp.26-32.

control group, a significant increase was observed. Likewise, the indicators of psychological stress showed highly significant difference in control group compared with significant difference in yoga group. During the examination, the increase in serum cortisol and decrease in serum IFN- in yoga group was less significant ($P < 0.01$) than in the control group ($P < 0.001$). Both the groups demonstrated an increase in serum IL-4 levels, the changes being insignificant for the duration of the study.

2.3 Studies on Stress and Alternative Therapies in Practice

Several pieces of evidence suggest that academic examinations fulfill the classical requirement of a psychological stressor. Academic examinations represent a stressful challenge to many students, but studies on examination-dependent corticosteroid response, a sensitive physiological indicator of a stress response, are inconsistent. In addition, several studies showed that music can decrease cortisol and adrenocorticotrophic hormone (ACTH) levels, and other studies have found that music also may enhance a variety of cognitive functions, such as attention, learning, communication and memory. Therefore, Laohawattanakun *et al.*, (2011)⁵⁴ investigated cortisol response in saliva of Thai adolescents taking academic examinations and analyzed the differences of the stress response between musician and control subjects. Also, observed whether the academic examination-dependent corticosteroid response affected learning and memory in the test subjects, which comprised 30 musician and 30 control students, age ranging from 15 to 17 years. Mathematical examinations were used as the stressor. Pre- and post-academic examination saliva cortisol levels were measured including self-estimated stress levels. Results showed that the pre-academic examination saliva cortisol concentrations of the musician group are significantly lower than those of the control group, whereas there is no difference in the stress

⁵⁴ J. Laohawattanakun, S. Chearskul, H. Dumrongphol, N. Jutapakdeegul, J. Yensukjai, N. Khumphan, S. Niltiean, and W. Thangnipon, "Influence of music training on academic examination-induced stress in Thai adolescents." *Neuroscience Letter*, 487, 3, 2011, pp.310-312.

inventory scores. Interestingly, among students with grade point average (GPA) of >3.50, pre-academic examination cortisol levels are significantly lower in the musician compared with control group. This study suggests that under academic examination-induced stress condition, music training can reduce saliva cortisol level in Thai adolescents.

Seo (2009)⁵⁵ conducted a study to examine the effects of aromatherapy on stress and stress responses in adolescents. A two-group cross-over design was used for this study. The experimental treatment was aroma essential oil inhalation and the placebo treatment was carrier oil inhalation using a necklace. The sample included 36 female high school students. Fisher's exact test, t-test, and paired t-test using SPSS/WIN program were used to analyze the data. The results indicate that Stress levels were significantly lower when the students received the aroma treatment compared to when they received the placebo treatment. The stress responses except salivary IgA levels were significantly lower when the students received the aroma treatment. The result of this suggests that Aroma inhalation could be a very effective stress management method for high school students. Therefore, it is recommended that this program be used in clinical practice as an effective nursing intervention for high school students.

Lee, Park and Moon (2004)⁵⁶ investigated the efficacy of Ondamtanggamibang, a Korean traditional herbal remedy, as a treatment of stress-related psychophysiological variables in healthy medical students experiencing examination stress. Forty volunteers were randomly assigned to either an herbal remedy group (n = 20) or a placebo control group (n = 20). After treatment, systolic blood pressure and plasma concentrations of norepinephrine and cortisol concentrations decreased significantly in the

⁵⁵ J. Y. Seo, "The effects of aromatherapy on stress and stress responses in adolescents." *Journal of Korean Academic Nursing*, 39, 3, 2009, pp.357-365.

⁵⁶ M. S. Lee, K. W. Park, and S. R. Moon, "Effects of a Korean traditional herbal remedy on psychoneuroendocrine responses to examination stress in medical students: a randomized placebo-controlled trial." *Human Psychopharmacology*, 19, 8, 2004, pp.537-543.

herbal remedy group. The herbal remedy group also exhibited beneficial changes in psychological variables such as anxiety, depression, stress and emotional state. These results suggest that a Korean traditional herbal remedy may reduce systolic blood pressure and catecholamine levels, possibly by stabilizing the sympathetic nervous system. This herbal remedy also reduced the negative psychological symptoms, stress and heightened the emotional state experienced by medical students during examinations.

Maclaughlin *et al.*, (2011)⁵⁷ assessed the stress-reducing effects of Mind Body Medicine Skill program by measuring physiological changes in first-year medical students. Saliva samples were collected before (January, time 1 (T1)-pre-intervention) and upon completion of the course (May, time 2 (T2p)-post-intervention), as well as from non-participating medical students (May, time 2 (T2c)-control). The T2p and T2c collections coincided with the period of final examinations. Cortisol, dehydroepiandrosterone-sulfate (DHEA-S), testosterone and secretory immunoglobulin A (sIgA) were measured. The mean morning salivary cortisol at T2p was 97% of the mean at baseline T1 which was significantly lower than for T2c (2.4) (95% confidence interval (CI) 0.57-1.60, $P = .001$); DHEA-S showed similar pattern as cortisol where the T2p levels were significantly lower than T2c ($P < .001$) in both morning and evening collections. Testosterone ratio at T2p (0.85) was also lower than T2c (1.6) (95% CI 0.53-1.3, $P = .01$). sIgA levels were not statistically different. On direct comparison, the T2c and T2p means were significantly different for all cortisol, DHEA-S and testosterone values. Participants maintained their hormonal balance within the normal range throughout the academic semester while the control group showed significantly increased levels, probably exacerbated by the end of the semester exam stress.

To assess the effectiveness of a stress reduction elective on Year 2 medical students and to assess the sustainability of any noted improvement.

⁵⁷ B. W. Maclaughlin, D. Wang, A. M. Noone, N. Liu, N. Harazduk, M. Lumpkin, A. Haramati, P. Saunders, M. Dutton, and H. Amri, "Stress biomarkers in medical students participating in a mind body medicine skills program." *Evidence Based Complementary and Alternative Medicine*, 2011, 950461.

A new elective entitled 'Mind-Body Medicine: an Experiential Elective' was offered to Year 2 medical students (Finkelstein *et al.*, 2007)⁵⁸. It was based on a course developed by the Center for Mind-Body Medicine. Enrolled students were surveyed on the first (time 1) and last (time 2) days of the elective and again 3 months later (time 3). Four validated self-report instruments were used to examine effects on anxiety, stress, mood states and depression. A comparison group of non-enrolled classmates completed the same instruments during the same timeframes. The study began in autumn 2004 and ended in June 2005. Participating students had higher initial anxiety scores than students in the comparison group. Anxiety in the study group declined significantly during the course, with enrolled students becoming indistinguishable from non-enrolled counterparts. These decreased anxiety levels were sustained for 3 months following the conclusion of the course. The findings suggest that this elective was successful in attracting students who were more anxious than their peers. Enrolees had higher baseline anxiety levels than their peers. The course decreased anxiety levels. The significant drop in anxiety scores of the study group suggests that this mind-body elective was an effective way to decrease anxiety in these pre-clinical medical students. Decreases in anxiety were sustained 3 months after the course ended, indicating that the benefits of the course may be long-lasting.

Medical students experience various stresses and many poor health behaviours. Previous studies consistently show that student wellbeing is at its lowest pre-exam. Little core-curriculum is traditionally dedicated to providing self-care skills for medical students. This paper by Hassed, Lisle, Sullivan and Pier (2009)⁵⁹ describes the development, implementation and outcomes of the Health Enhancement Program (HEP) at Monash University. It comprises mindfulness and ESSENCE lifestyle programs, is experientially-based, and

⁵⁸ C. Finkelstein, A. Brownstein, C. Scott, and Y. L. Lan, "Anxiety and stress reduction in medical education: an intervention." *Medical Education*, 41, 3, 2007, pp.258-264.

⁵⁹ C. Hassed, S. de Lisle, G. Sullivan, and C. Pier, "Enhancing the health of medical students: outcomes of an integrated mindfulness and lifestyle program." *Advances in Health Science Education Theory and Practice*, 14, 3, 2009, pp.387-398.

integrates with biomedical sciences, clinical skills and assessment. This study measured the program's impact on medical student psychological distress and quality of life. A cohort study performed on the 2006 first-year intake measured effects of the HEP on various markers of wellbeing. Instruments used were the depression, anxiety and hostility subscales of the Symptom Checklist-90-R incorporating the Global Severity Index (GSI) and the WHO Quality of Life (WHOQOL) questionnaire. Pre-course data (T1) was gathered mid-semester and post-course data (T2) corresponded with pre-exam week. To examine differences between T1 and T2 repeated measures ANOVA was used for the GSI and two separate repeated measures MANOVAs were used to examine changes in the subscales of the SCL-90-R and the WHOQOL-BREF. Follow-up t-tests were conducted to examine differences between individual subscales. A total of 148 of an eligible 270 students returned data at T1 and T2 giving a response rate of 55%. 90.5% of students reported personally applying the mindfulness practices. Improved student wellbeing was noted on all measures and reached statistical significance for the depression (mean T1 = 0.91, T2 = 0.78; $p = 0.01$) and hostility (0.62, 0.49; 0.03) subscales and the GSI (0.73, 0.64; 0.02) of the SCL-90, but not the anxiety subscale (0.62, 0.54; 0.11). Statistically significant results were also found for the psychological domain (62.42, 65.62; $p < 0.001$) but not the physical domain (69.11, 70.90; $p = 0.07$) of the WHOQOL. This study is the first to demonstrate an overall improvement in medical student wellbeing during the pre-exam period suggesting that the common decline in wellbeing is avoidable.

Saunders *et al.*, (2007)⁶⁰ conducted a study with the aim to understand the impact of mind body skills course on students' self-awareness, self-reflection, and self-care as part of their medical education experience. This study used a qualitative content analysis approach to data analysis. The data

⁶⁰ P. A. Saunders, R. E. Tractenberg, R. Chaterji, H. Amri, N. Harazduk, J. S. Gordon, M. Lumpkin, and A. Haramati, "Promoting self-awareness and reflection through an experiential mind-body skills course for first year medical students." *Medical Teacher*, 29, 8, 2007, pp.778-784.

were 492 verbatim responses from 82 students to six open-ended questions about the students' experiences and attitudes after a mind-body skills course. These questions queried students' attitudes about mind-body medicine, complementary medicine, and their future as physicians using these approaches. The data revealed five central themes in students' responses: connections, self discovery, stress relief, learning, and medical education. The findings revealed that Mind-body skills groups can enable students to achieve self-awareness and self-reflection in order to engage in self-care and to gain exposure to mind-body medicine while in medical school.

Esch, Duckstein, Welke and Braun (2007)⁶¹ conducted a prospective, longitudinal pilot study over 18 weeks for the evaluation of subjective and objective clinical effects of a Yang style Tai Chi intervention in young adults (beginners) by measuring physiological (blood pressure, heart rate, saliva cortisol) and psychological (SF-36, perceived stress, significant events) parameters, i.e, direct or indirect indicators of stress and stress reduction, in a non-randomised/-controlled, yet non-selected cohort (n=21) by pre-to-post comparison and in follow-up. SF-36 values were also compared with the age-adjusted norm population, serving as an external control. Additionally, they measured diurnal cortisol profiles in a cross-sectional sub-study (n=2+2, pre-to-post), providing an internal random control sub-sample. Only nine participants completed all measurements. Even so, investigators found significant ($p<0.05$) reductions of saliva cortisol (post and follow-up), which seems to be an indicator of general stress reduction. A significant decrease in perceived mental stress (post) proved even highly significant ($p<0.01$) in the follow-up, whereas physical stress perception declined to a much lesser degree. Significant improvements were also detected for the SF-36 dimensions general health perception, social functioning, vitality, and mental health/psychological well-being. Thus, the summarized mental health

⁶¹ T. Esch, J. Duckstein, J. Welke, and V. Braun, "Mind/body techniques for physiological and psychological stress reduction: stress management via Tai Chi training - a pilot study." *Medical Science Monitor*, 13, 11, 2007, pp.488-497.

measures all clearly improved, pointing towards a predominantly psychological impact of TC.

McCraty *et al.*, (1998)⁶² examined the effects on healthy adults of a new emotional self-management program, consisting of two key techniques, "Cut-Thru" and the "Heart Lock-In." These techniques are designed to eliminate negative thought loops and promote sustained positive emotional states. The hypotheses were that training and practice in these techniques would yield lowered levels of stress and negative emotion and cortisol, while resulting in increased positive emotion and DHEA levels over a one-month period. In addition, it was hypothesized that increased coherence in heart rate variability patterns would be observed during the practice of the techniques. Forty-five healthy adults participated in the study, fifteen of whom acted as a comparison group for the psychological measures. Salivary DHEA/DHEAS and cortisol levels were measured, autonomic nervous system function was assessed by heart rate variability analysis, and emotions were measured using a psychological questionnaire. Individuals in the experimental group were assessed before and four weeks after receiving training in the self-management techniques. The experimental group experienced significant increases in the positive affect scales of Caring and Vigor and significant decreases in the negative affect scales of Guilt, Hostility, Burnout, Anxiety and Stress Effects, while no significant changes were seen in the comparison group. There was a mean 23 percent reduction in cortisol and a 100 percent increase in DHEA/DHEAS in the experimental group. DHEA was significantly and positively related to the affective state Warmheartedness, whereas cortisol was significantly and positively related to Stress Effects. Increased coherence in heart rate variability patterns was measured in 80 percent of the experimental group during the use of the techniques. The results suggest that techniques designed to eliminate negative thought loops can have important

⁶² R. McCraty, B. Barrios-Choplin, D. Rozman, M. Atkinson, and A. D. Watkins, "The impact of a new emotional self-management program on stress, emotions, heart rate variability, DHEA and cortisol." *Integrative Physiology and Behavioral Science*, 33, 2, 1998, pp.151-170.

positive effects on stress, emotions and key physiological systems. The implications are that relatively inexpensive interventions may dramatically and positively impact individuals' health and well-being. Thus, individuals may have greater control over their minds, bodies and health than previously suspected.

Straten, Cuijpers and Smits (2008)⁶³ studied whether a Web-based self-help intervention is effective in reducing depression, anxiety, and work-related stress (burnout). A total of 213 participants were recruited through mass media and randomized to the intervention (n = 107) or a waiting list control group (n = 106). The Web-based course took 4 weeks. Every week an automated email was sent to the participants to explain the contents and exercises for the coming week. In addition, participants were supported by trained psychology students who offered feedback by email on the completed exercises. The core element of the intervention was a procedure in which the participants learn to approach solvable problems in a structured way. At pre-test and post-test, the following primary outcomes: depression (CES-D and MDI), anxiety (SCL-A and HADS), and work-related stress (MBI). Quality of life (EQ-5D) were measured as a secondary outcome. Of the 213 participants, 177 (83.1%) completed the baseline and follow-up questionnaires; missing data were statistically imputed. Of all 107 participants in the intervention group, 9% (n = 10) dropped out before the course started and 55% (n = 59) completed the whole course. Among all participants, the intervention was effective in reducing symptoms of depression (CES-D: Cohen's d = 0.50, 95% confidence interval (CI) 0.22-0.79; MDI: d = 0.33, 95% CI 0.03-0.63) and anxiety (SCL-A: d = 0.42, 95% CI 0.14-0.70; HADS: d = 0.33, 95% CI 0.04-0.61) as well as in enhancing quality of life (d = 0.31, 95% CI 0.03-0.60). Moreover, a higher percentage of patients in the intervention group experienced a significant improvement in symptoms (CES-D: odds ratio [OR]

⁶³ A. van Straten, P. Cuijpers, and N. Smits, "Effectiveness of a web-based self-help intervention for symptoms of depression, anxiety, and stress: randomized controlled trial." *Journal of Medical Internet Research*, 10, 2008, 1, e7.

= 3.5, 95% CI 1.9-6.7; MDI: OR = 3.7, 95% CI 1.4-10.0; SCL-A: OR = 2.1, 95% CI 1.0-4.6; HADS: OR = 3.1, 95% CI 1.6-6.0). Patients in the intervention group also recovered more often (MDI: OR = 2.2; SCL-A: OR = 2.0; HADS < 8), although these results were not statistically significant. The course was less effective for work-related stress, but participants in the intervention group recovered more often from burnout than those in the control group (OR = 4.0, 95% CI 1.2-13.5). The results demonstrated statistically and clinically significant effects on symptoms of depression and anxiety. These effects were even more pronounced among participants with more severe baseline problems and for participants who fully completed the course. The effects on work-related stress and quality of life were less clear.

It has been well documented that nursing students across the world experience stress and anxiety throughout their education and training. The purpose of this randomized controlled study conducted by Ratanasiripong, Ratanasiripong and Kathalae (2012)⁶⁴ was to investigate the impact of biofeedback intervention program on nursing students' levels of stress and anxiety during their first clinical training. Participants consisted of 60 second-year baccalaureate nursing students. The 30 participants in the biofeedback group received training on how to use the biofeedback device to assist in stress and anxiety management for 5 weeks while the 30 in the control group did not receive any training. Results indicated that the biofeedback group was able to maintain the stress level while the control group had a significant increase in the stress level over the 5-week period of clinical training. Additionally, the biofeedback group had a significant reduction in anxiety, while the control group had a moderate increase in anxiety.

⁶⁴ P. Ratanasiripong, N. Ratanasiripong, and D. Kathalae, "Biofeedback Intervention for Stress and Anxiety among Nursing Students: A Randomized Controlled Trial." *ISRN Nursing*, 2012, 827972.

McFadden *et al.*, (2012)⁶⁵ used a randomized, placebo-controlled, single-blind design to investigate the use of a single acupressure treatment for stress reduction in healthy college students (n=109) during a stressor. Participants were randomly assigned to one of three single, 40-min interventions: active acupressure, placebo acupressure, or a relaxation CD control. A math task stressor administered before and after the intervention assessed intervention effects on stressor responsivity. Stress responses were measured by physiological (heart rate (HR), heart rate variability (HRV), skin conductance response (SCR)) and subjective measures (State Anxiety Inventory, nine-item Psychological Stress Measure) of anxiety and stress. All interventions were associated with the following changes during the post-intervention stressor compared to the pre-intervention stressor: reduced HR ($p < 0.001$), increased HRV ($p < 0.024$), reduced SCR ($p < 0.001$), reduced subjective stress scores ($p < 0.001$), and increased correct answers ($p < 0.001$). Although all groups demonstrated stress reduction, there were no significant group differences after a single treatment. The result indicate that all interventions significantly reduced the stress response, although not differently. The lack of active acupressure-associated treatment effects appears to be due to insufficient dosing.

Yazdani, Rezaei and Pahlavanzadeh (2010)⁶⁶ aimed to determine the effectiveness of stress management training program on depression, anxiety and stress rate of the nursing students. This parallel group randomized quasi-experimental trial, was done on 68 Bs nursing students of Nursing and Midwifery School in Isfahan University of Medical Sciences from 2010 to 2011. The questionnaires of this study consisted of individual characteristics and Depression, Anxiety and Stress Scale (DASS-42). In a random fashion,

⁶⁵ K. L. McFadden, K. M. Healy, K. P. Hoversten, T. A. Ito, and T. D. Hernandez, "Efficacy of acupressure for non-pharmacological stress reduction in college students." *Complementary Therapies in Medicine*, 20, 4, 2012, pp.175-182.

⁶⁶ M. Yazdani, S. Rezaei, and S. Pahlavanzadeh, "The effectiveness of stress management training program on depression, anxiety and stress of the nursing students." *Iran Journal of Nursing and Midwifery Research*, 15, 4, 2010, pp.208-215.

The intervention group was trained with stress management training program in 8 two hours sessions, twice a week. The questionnaires were completed by both groups before, after and one month after the study. The results of the study indicated that there was no significant difference before the intervention in depression, anxiety and stress mean scores in the two groups. After the intervention, the mean scores of anxiety and stress in the intervention group was 5.09 (4.87) and 8.93 (6.01) and in the control group was 10 (6.45) and 13.17 (7.20), that reduction in depression mean score was significantly greater in the intervention group in the control group ($p = 0.040$). Furthermore, the mean scores of anxiety and stress showed a significant difference between the two groups (Anxiety $p = 0.001$; Stress $p = 0.011$); this reduction also had been remained after a month. According to the results of the present study, holding stress management training program workshops in different courses of the mental health department can improve mental health of the students.

A Stress Inoculation Training-based protocol tested if multimedia audio-video content induced emotional changes and reduced exam anxiety in university students(Grassi, Gaggioli and Riva 2011)⁶⁷. Seventy-five participants took part in six experimental sessions consisting of viewing multimedia content and performing relaxation exercises. Participants were randomly assigned to five experimental groups: 1) audio and video narrative on mobile phone (UMTS); 2) audio and video narrative on DVD (DVD), 3) audio narrative on MP3 player (M3), 4) audio narrative on CD (CD), 5) control group (CTRL). Results showed that audio/video content induced a significant reduction in exam anxiety and an increase of relaxation in students, compared to the audio-only contents.

This is a constructive replication of a previous trial conducted by Bowden *et al.* (2010), where students who had received Reiki demonstrated

⁶⁷ A. Grassi, A. Gaggioli, and G. Riva, "New technologies to manage exam anxiety." *Studies in Health Technology and Informatics*, 167, 2011, pp.57-62.

greater health and mood benefits than those who received no Reiki. The current study by Bowden *et al.*, (2011)⁶⁸ examined impact on anxiety/depression. 40 university students-half with high depression and/or anxiety and half with low depression and/or anxiety-were randomly assigned to receive Reiki or to a non-Reiki control group. Participants experienced six 30-minute sessions over a period of two to eight weeks, where they were blind to whether noncontact Reiki was administered as their attention was absorbed in a guided relaxation. The efficacy of the intervention was assessed pre-post intervention and at five-week follow-up by self-report measures of mood, illness symptoms, and sleep. The participants with high anxiety and/or depression who received Reiki showed a progressive improvement in overall mood, which was significantly better at five-week follow-up, while no change was seen in the controls. While the Reiki group did not demonstrate the comparatively greater reduction in symptoms of illness seen in our earlier study, the findings of both studies suggest that Reiki may benefit mood.

Gomes, Silva and Araujo (2008)⁶⁹ conducted a quantitative research with 42 students of a public university using the Therapeutic Touch - Krieger-Kunz Method and the application of a questionnaire validated in Brazil to assess anxiety in three sessions. Subjects were divided into two groups: experimental (1), in which the complementary therapy was used; and control (2), in which a mock of the technique, with no therapeutic intention, was applied. The objective was to identify the gradual influence of that health complementary therapy upon the students' state of anxiety. The analysis of the data showed a statistically significant reduction of the state of anxiety in both groups, with $p < 0.05$.

⁶⁸ D. Bowden, L. Goddard, and J. Gruzelier, "A randomised controlled single-blind trial of the efficacy of reiki at benefitting mood and well-being." Evidence Based Complementary and Alternative Medicine, 2011, 381862.

⁶⁹ V. M. Gomes, M. J. Silva, and E. A. Araujo, "Gradual effects of therapeutic touch in reducing anxiety in university students." Rev Bras Enferm, 61, 6, 2008, pp.841-846.

Lai *et al.*, (2008)⁷⁰ assessed the effect of lento music on examination anxiety among nursing students. A randomized crossover classroom-based trial was conducted. Thirty-eight students with a mean age of 19.4 years (SD = .54) were randomly assigned to either a music/silence or a silence/music group sequence. The students in the music group were given a 40-min group-based music intervention in a classroom, whereas the students in the silence group received the regular test without music. Using paired t-tests, there were no significant difference in pretest scores for state anxiety, examination anxiety, finger temperature and pulse rate between the two conditions. Nonetheless, the findings indicated that music intervention did effectively decrease examination anxiety and state anxiety as well as reducing pulse rate and increasing higher finger temperature ($p = 0.05$ to 0.001). In addition, significant differences were detected between the pretest and posttest measures for silence ($p = 0.001$). The results suggest that lento music is effective at anxiety reduction. This study provides evidence for nursing faculty and clinical educators to foster nursing students' mastering over the anxiety of examination by using lento music.

Various rituals have been shown to have both psychologic as well as physical effects. However, many rituals have multiple components that can account for such effects. Few studies have distinguished between the effects of ritual and those related specifically to religious content and teachings. This study conducted by Anastasi and Newberg (2008)⁷¹ investigated the acute effects of the ritual of reciting the Rosary, which contains relatively little specific religious content compared to receiving specific teaching of religious concepts, on the level of anxiety. 30 students in a Catholic college divided into two intervention groups. Twelve (12) students participated in recitation of the Rosary, whereas 18 students viewed a religiously oriented video. Both groups

⁷⁰ H. L. Lai, P. W. Chen, C. J. Chen, H. K. Chang, T. C. Peng, and F. M. Chang, "Randomized crossover trial studying the effect of music on examination anxiety." *Nurse Education Today*, 28, 8, 2008, pp.909-916.

⁷¹ M. W. Anastasi, and A. B. Newberg, "A preliminary study of the acute effects of religious ritual on anxiety." *Journal of Alternative Complementary Medicine*, 14, 2, 2008, pp.163-165.

were measured for anxiety pre- and post intervention through the use of the State-Trait Anxiety Inventory. The result indicated a significant reduction in anxiety in subjects reciting the Rosary compared to the group of subjects watching the video. These preliminary results suggest that ritual itself may be a significant contributor to the effects of religious practices on psychological well-being.

Sharif and Armitage (2004)⁷² investigated the effect of psychological and educational counselling in reducing anxiety in nursing students. The research study used methodological triangulation, involving the use of structured data collection techniques such as standardized questionnaires and semi-structured focus groups. Focus groups were used to provide greater insight regarding the student's opinions. The sample consisted of 100 second- and fourth-year baccalaureate nursing students from the Faculty of Nursing at Shiraz University of Medical Sciences, Iran. They were randomly assigned to either an experimental group (n = 50) or a control group (n = 50). The experimental group received a 12-week intervention programme. Quantitative analysis of data was undertaken using t-test and analysis of variance for repeated measures to test differences between and within groups. The results indicated that from pre- to post-test there was no statistically significant reduction in anxiety between groups, but there was a statistically significant reduction in anxiety after one semester (in the follow-up). Student self-esteem was increased significantly from pre- to post-test. This increase was statistically significant and remained the same in follow-up. A statistically significant difference was seen in the student grade point average from pre-test to follow-up in the experimental group but not for the control group. The implementation of an intervention programme reduced their anxiety, increased their self-esteem and improved their grade point average over time.

⁷² F. Sharif, and P. Armitage, "The effect of psychological and educational counselling in reducing anxiety in nursing students." *Journal of Psychiatric Mental Health Nursing*, 11, 4, 2004, pp.386-392.

The use of music as a method of relieving anxiety has been studied extensively by researchers from varying disciplines. The abundance of these reports focused on which genre of music best aided in the relief of stress. Little work has been performed in the area of auditory preference in an attempt to ascertain whether an individual's preferred music type aids in their anxiety reduction at levels greater than music that they have little or no propensity for. Therefore, Salamon *et al.*, (2003)⁷³ determined whether naive human subjects exposed to music of their preference show a decrease in anxiety, as measured by systolic and diastolic blood pressure values. The results show statistically significant reduction of anxiety levels only when subjects were exposed to their preferred musical selections. From the results it was concluded that music therapy may provide a mechanism for self-understanding and subsequently help alleviate anxiety and stress.

Baker *et al.*, (2003)⁷⁴ conducted a study with following objectives: (1) To replicate a study of the efficacy of Argentum nitricum 12X in the reduction of test anxiety as demonstrated previously. (2) To investigate the correlation between individuals identified to match the A. nitricum profile and the reduction of test anxiety. To compare traditionally prepared homeopathic A. nitricum 12X with radionically-prepared A. nitricum 12X and placebo. Sixty-two test anxious university students were recruited for this study. Subjects were randomised to one of three groups: traditionally prepared homeopathic A. nitricum 12X, radionically-prepared A. nitricum 12X, or placebo. After screening, each group received treatment twice a day for 4 days after which they were re-tested. Primary: The Revised Test Anxiety Scale. Secondary: The Test Anxiety Scale; 36-item A. nitricum questionnaire. The results of this study did not replicate the Stanton study. No correlation between the reduction of test anxiety and the A. nitricum profile was demonstrated. No

⁷³ E. Salamon, S. R. Bernstein, S. A. Kim, M. Kim, and G. B. Stefano, "The effects of auditory perception and musical preference on anxiety in naive human subjects." *Medical Science Monitor*, 9, 9, 2003, pp.396-399.

⁷⁴ D. G. Baker, S. P. Myers, I. Howden, and L. Brooks , "The effects of homeopathic Argentum nitricum on test anxiety." *Complementary Therapies in Medicine*, 11, 2, 2003, pp.65-71.

significant differences between treatments were demonstrated. This study demonstrated that homeopathic A. nitricum 12X does not reduce test anxiety in a general population of university students.

The literature presented above indicates that examination stress/anxiety can produce mental or physiological reactions that may lead to illness. Mild stress may be beneficial in cognitive tasks and performance while persistently high stress may lead to anxiety and depression. In fact, stress response is characterized by an increase in corticosteroid hormone release which may lead to physical and mental ill health.

Nevertheless, after reviewing literature on the subject, it was discovered that there are various adjuvant therapies/techniques evolved to overcome the anxiety and/or stress faced during examination. The use of Yoga practices to relieve anxiety/stress has been studied extensively by researchers from varying disciplines. The abundance of these reports focused on various disorders but little or no work has been performed in the area of students appearing for board examinations. Hence, this study was undertaken in an attempt to ascertain whether yoga practices can reduce anxiety and bring homeostasis in corticosteroid hormones among students appearing for board examination.