

RESEARCH ARTICLE

A comparative study of gender difference in reaction time in response to exam stress among first-year medical students

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ABSTRACT

Background: Different studies conducted worldwide among medical students have reported the prevalence of stress ranging from 27% to 73%. Exam stress acts as an acute stressor which affects cognitive functions. It is found that the exam stress elicits elevated activity in the hypothalamic-pituitary-adrenal axis and increased release of cortisol. **Aims and Objective:** The study was planned to investigate gender difference in perceptions of exam stress and reactions to it among first-year medical students. Choice reaction time (CRT) was used to evaluate the cognitive performance of students during stress-free and stress (exam) conditions. **Materials and Methods:** The study was conducted on 60 healthy first year MBBS students (30 boys and 30 girls) between the age group of 18 and 20 years. Digital reaction time was used. Randomly occurring visual and auditory CRT tasks were presented to students. First set of readings was taken during stress-free period, and the second and third sets were taken 20 min before first and second terminal practical examination, respectively. **Results:** The readings were analyzed by unpaired Student's *t*-test. Results showed that visual and auditory reaction times were increased in both boys and girls with statistically significant difference between boys and girls in stress (exam) condition, but no difference during stress-free condition. **Conclusion:** The observation shows that girls tend to perceive more stress than boys which might affect the cognitive functions more, as slower reaction time was observed in girls than boys when they were exposed to stress.

KEY WORDS: Choice Reaction Time; Cognitive; Exam; Gender; Stress

INTRODUCTION

Stress indicates the consequence of the failure of an organism, human, or animal to respond appropriately to emotional or physical threats whether is either actual or imagined.^[1,2] Stress is a structured series of physiological,

neurohormonal, and psychological efforts of adaptation toward any real and anticipated situations that threatens or disturbs homeostatic balance of the body and that require some kind of adjustments.^[3,4]

Academic stress is an inevitable feature of students' life where periodic examinations become an acute stressful experience for them. Academic stress is the product of a combination of academic-related demands that exceed the adaptive resources available to an individual.^[5,6] Although there are many factors causing stress in the life of medical students, which can possibly affect the cognitive performance, examination acts as an acute natural stressor.^[7] Exam stress is predominant among medical students which is proved by various studies

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conducted among medical students have reported the prevalence of stress ranging from 27% to 73%.^[1,8] The first year MBBS students face a major challenge, especially during practical examination, where they are exposed to “viva voce” for the first time. The experience of stress among college students is considered normal, but if stress is severe and/or prolonged, it can reduce academic performance; interfere with a student’s ability to participate in and contribute to campus life.^[5]

Reaction time is defined as an interval of time between presentation of stimulus and appearance of appropriate voluntary response in a subject.^[9,10] In choice reaction time (CRT) tasks, the student is presented with several stimuli and has to discriminate between various stimuli to make a choice among appropriate response. Thus, CRT is a cognitive process which involves recognition, discrimination, and analysis of stimulus and decision-making for appropriate response selection.^[10,11] In the present study, CRT tasks were given during exam (stress) and stress-free condition to assess the cognitive performance in medical students.

The studies on the perception of stress based on gender are inconsistent as findings of these studies are conflicting. There are evidences which demonstrate that females report more distress to fear-producing and stressful experiences than males.^[12,13] Some of the human stress studies have largely indicated that physiological responses to acute stress do not differ in men and women.^[14-16] There are some evidences which indicate that adult men respond to psychological stress with greater increases in adrenocorticotropin hormone (ACTH) and salivary cortisol levels compared to women.^[13,14] Due to these conflicting evidences regarding sex differences in response to stress, the present study was undertaken to evaluate potential gender difference in stress reactivity in medical students when they were exposed to stressful events such as examination. CRT was used to find out the performance of students during stress-free and stress (exam) condition.

MATERIALS AND METHODS

Study Population

The study was conducted on 60 healthy first-year medical students (30 boys and 30 girls) between the age group of 18 and 20 years who were randomly selected at Topiwala National Medical College, Mumbai. The students who had a history of color blindness, hearing impairments, and sensory-motor disability were excluded from the study. Female participants with a history of irregular menstrual cycles and use of contraceptive pills were excluded from the study, and only with regular 28-30 days cycle were included in the study. Given that early follicular phase in women (when oestrogen and progesterone are low) is hormonally more

similar to men compared with late follicular/mid-cycle (when oestrogen is high) or luteal (when progesterone is high), female participants in early follicular phase were selected in this study.^[17]

Participation of students was purely on voluntary basis. Informed consent was taken from all the participants. The study was approved by the Institutional Ethics Committee of B.Y.L. Nair Charitable Hospital, Mumbai.

Material

Digital reaction time apparatus manufactured by Bio-Tech (India), Mumbai, which has got maximum resolution time of 0.0001 s was used in this study.

Methods

CRT in the form of visual and auditory signals was used in the present study. The examiner sits with master (primary) controls, whereas student sits on other side with secondary controls. The examiner and student were separated with the help of opaque partition so that student avoids seeing which switch the examiner presses. The examiner randomly presents either the visual (red or green lights) or auditory signal (high or low-frequency sounds) to the student. The student immediately responds by pressing an appropriate corresponding switch on his/her side. The time duration between the application of stimulus by examiner and registering the response from the student is taken as reaction time. This was recorded on reaction time apparatus in seconds. In the beginning, two to three practice sessions were given to the students. After that, four such test recordings were taken and the averages of these recordings were taken as final record for each student. One set of recordings was taken in “stress-free” condition that is 3 months before the first terminal examination and the second and third sets of recordings were taken 20 min before the commencement of the first and second terminal practical examinations, respectively. Statistical analysis was done with the help of unpaired *t*-test. $P < 0.05$ was considered statistically significant.

RESULTS

Tables 1, 2 and 3 show visual reaction time for red and green lights (VRT) and auditory reaction time for high and low-frequency sounds (ART) in boys and girls in stress-free period and, during first and second terminal practical examination (stress), respectively.

Table 1 shows that there was statistically no significant difference in either VRT or ART among boys and girls in stress-free condition. Whereas in the first terminal examination (Table 2), there is statistically significant difference among boys and girls in VRT and ART in stressful condition.

Table 1: Reaction time in boys and girls in stress-free period

Parameters	Boys	Girls	t-test
VRT red signal	0.2632±0.062	0.2781±0.046	Ns
VRT green signal	0.2493±0.059	0.2617±0.052	Ns
ART high frequency sound	0.3695±0.066	0.4048±0.088	Ns
ART low frequency sound	0.3708±0.074	0.4194±0.086	Ns

Values are given with±standard deviation (SD). NS: Not significant. VRT: Visual reaction time, ART: Auditory reaction time. Reaction time given in table is in seconds

Table 2: Reaction time in boys and girls in the first terminal examination period

Parameters	Boys	Girls	t-test
VRT red signal	0.3321±0.098	0.4026±0.119	**
VRT green signal	0.3118±0.113	0.3862±0.123	**
ART high frequency sound	0.4712±0.102	0.5620±0.169	**
ART low frequency sound	0.5206±0.109	0.6256±0.209	**

Values are given with±standard deviation. $P<0.05$. **significant, VRT: Visual reaction time; ART: Auditory reaction time. Reaction time given in table is in seconds, SD: Standard deviation

Table 3: Reaction time in boys and girls in the second terminal examination period

Parameters	Boys	Girls	t-test
VRT red signal	0.3226±0.077	0.3992±0.168	**
VRT green signal	0.3121±0.086	0.3638±0.164	Ns
ART high frequency sound	0.4343±0.095	0.5459±0.218	***
ART low frequency sound	0.5115±0.149	0.6134±0.252	**

Values are given with±standard deviation. $P<0.05$. **significant ***highly significant NS: Not significant, VRT: Visual reaction time, ART: Auditory reaction time. Reaction time given in table is in seconds, SD: Standard deviation

While during the second terminal examination (Table 3), it was also observed that there is statistically significant difference among boys and girls in visual and ART in stress condition except in VRT in green signal.

DISCUSSION

There is good evidence to suggest that the stress of examination elicits elevated activity in the hypothalamic-pituitary-adrenal (HPA) axis and increased release of cortisol.^[18] Previous studies have demonstrated that females tend to perceive more stress than males and those females are more likely to become depressed in response to these stressors than men.^[19,20] This supports the idea that women may be perceiving similar life events as more negative as compared to men and contributing to their tendency to report higher trait anxiety and depressive symptoms.^[20] The findings of this study are in agreement with the findings of Busari (2012),

Misra and McKean (2000), Sulaiman et al. (2009), and Matud (2004).^[5,21-23] According to Misra and McKean (2000), “individuals who scored high on trait anxiety experienced higher stressors and reactions to stressors. Females exhibited higher anxiety than males.”^[21] While Sulaiman et al. (2009) found that male students experienced less stress compared to the female students.^[22] Studies conducted by Hall et al. (2006), Adlaf et al. (2001), Hudd et al. (2000), Kelly et al. (2006), and Kudielka and Kirschbaum (2005) have also demonstrated that female students report greater levels of stress,^[24-26] and they report more distress to fear-producing and stressful experiences than men.^[12,13] The main mediators of the stress response are sympathetic nervous system and the HPA.^[27] The basic neuroendocrine core of stress responses triggers release of hypothalamic corticotrophin-releasing hormone (CRH) which stimulates the release of ACTH from the anterior pituitary, which, in turn, stimulates the adrenal cortex to release corticosteroids, especially cortisol or corticosterone.^[28] CRH serves as a neurotransmitter that mediates sympathetic arousal and provides link between the adrenocortical and autonomic branches of the stress response. Cortisol exerts a profound influence over prefrontal cortex (PFC) structure and functioning in response to stress. Stress mainly affects the cognitive functions by profound influence over PFC by impairment in PFC signaling and can modify cognitive functions in humans.^[10,29] The results of the neuroimaging study by Wang et al. (2007) showed that there was gender-specific neural activation model underlying central stress response.^[30] The model suggests asymmetric prefrontal activity in males and primarily limbic activation in females. Stress responses in men are primarily characterized as “fight-or-flight,” while in female, it causes limbic activation might indicate an intrinsic neurobiological mechanism to activate the reward system under stress, thereby downregulating the “fight-or-flight” response. Thus, the study showed relatively blunt acute stress response in stress tasks in female students.^[30] The study by Kajantie and Phillips (2006), agrees with greater acute HPA and autonomic responses in males as compared to females using performance stress paradigms.^[31]

The findings of this study are not in agreement with the results of the studies conducted by Kirschbaum et al. (1999), Kirschbaum et al. (1992), and Stoney et al. (1987).^[14-16]

Strengths and Limitations

To assess the effect of exam stress on the cognitive performance of students, CRT tasks were given just before the commencement of practical examinations when students were at maximum stress. To eliminate the possibility of false positive results by chance, the tests were given in two stressful conditions of examinations. However, there were limitations too; as direct measurements of stress hormones

were not taken. Second, the effect of menstrual cycle on stress hormones, especially cortisol and therefore stress response was not taken into consideration.

CONCLUSION

The results of the present study demonstrate that stress affects the cognitive performance of both boys and girls, but girls are affected more than boys to report higher levels of stress. The findings are consistent with most previous studies and further support the notion that on average, girls tend to perceive stressful life events as more stressful than men. These basic sex differences in the perception and response to stress could constitute a vulnerability to the subsequent development of depression and anxiety in females.

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