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Assesment of Stress and Correlation with EEG in Medical Students.

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ABSTRACT

Many people suffer from stress in their everyday life, while there is a close relationship between stress and mental health. A stress free medical curriculum is not possible or even desirable because some stress is required for learning. The aim and objective of this study was to find out stress among medical students and to observe the correlation between stress and EEG (Electroencephalogram) changes. 50 students were selected for this study by questionnaire method. Medical Students Stressor Questionnaire (MSSQ) was used for assessment of stress. EEG of each student was done. Parameters were compared by Mann-Whitney U Test, Kruskal-Wallis Test and Chi-Square test. Females experience more stress than males. Induced group has more stress than choice group. No significant difference in stress according to curricular year. Significant difference in stress according to socioeconomic status. SWED (Stress With Emotional Disturbance) group shows beta wave while SNED (Stress but No Emotional Disturbance) group shows alpha wave on EEG study. From this study it was confirmed that, some medical students experience stress during their study period.
Keywords: Medical students, Stress, Electroencephalogram, Alpha wave, Beta wave

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INTRODUCTION

The term stress was first employed in a biological context by endocrinologist Hans Selye in 1930s. Stress refers to the consequence of the failure of an organism – human or other animal - to respond adequately to mental, emotional or physical demands whether actual or imagined. According to Hans Selye stress refers to a condition and stressor refers to the stimulus. Defining the concept of stress has been a difficult task in psychological literature. Not only is there uncertainty in the terminology regarding the stress process, but also the application of the concept varies. In the late 1960s, Holmes and Rahe[1] approached stress as related to distinct events in environment, such as the death of a loved one or a financial crisis, leading to discernible change. Another major approach is the transactional model of Lazarus and Folkman[2] viewing stress as the result of appraising environmental events as stressful. The medical model describes stress as a reaction to psychological and physiological agents. An example of a medical centered perspective is the work of Hans Selye (1956/1976). He theorized that any noxious agent would produce a similar physiological defense, or stress reaction. Selye[3] published in 1975 a model dividing stress into eustress and distress. Where stress enhances function (physical or mental, such as through strength training or challenging work), it may be considered eustress. Persistent stress that is not resolved through coping or adaptation, considered as distress. Selye proposed the General Adaptation Syndrome (GAS) [4] that reflects the physiological changes following adverse emotional stimulation, i.e. prolonged stress. GAS consisted of three phases – an alarm phase, a resistance phase and an exhaustion phase – and the bodily stress response was proposed to be non-specific irrespective of the stressor. The hypothalamic-pituitary-adrenal (HPA) axis has a central part of Selye's formulation of GAS. Activation of the HPA system is associated with release of the hormones ACTH and cortisol. It has also been suggested that the analyses of temporal changes in the balance between SAM (Sympathetic Adrenal Medullary) system and the HPA axis may enhance the characterization of stress responses and stress related illnesses [5].

Activation or arousal of the stress systems leads to a cluster of behavioral and physiological changes that are remarkably consistent [6]. The stress response related to behavioral adaptation includes increased alertness and vigilance, improved cognition and focused attention, and inhibition of vegetative functions, such as appetite, feeding and reproductive function. The stress response related to physical adaptation aims at promoting an adaptive redirection of energy to the body sites where they are needed most, increased cardiovascular activity (elevated heart rate and blood pressure), increased respiratory rate and intermediate metabolism – all work in concert to promote availability of vital substrates. Electrical brain activity (measured with EEG) shows a desynchronized pattern during stress and strong excited emotions (e.g. fear) and beta frequencies are dominating [7]. In a relaxed, non-stressful state, the EEG contains an alpha activity. Mental stress can also contribute to increased muscle tension, reflected in elevated EMG activity particularly in the trapezius muscle [8]. Electrodermal measures such as skin conductance level and spontaneous fluctuations are well known indicators of arousal and may therefore show increased levels during stress [9]. Some eye measures may show associations with stress. For example, pupil dilatation and increased blinking frequency has been observed in studies of stress[9]. A general observation is that the correlations between physiological stress measures are rather weak and that the individual variability is high. However, within an

individual the stress response is usually fairly consistent, even when the stressor differs [10]. Acute stress affects an organism in short term while chronic stress affects in long term. Chronic stress has been found to be associated with abnormal autonomic nervous system functioning [11, 12]. So no doubt, stress is one of the major factor contributing to chronic disorders [13, 14]. Stress also influences the desire to work, performance at work, one's general attitude towards life, etc [15]. Stress also can increase social and economic loss and decrease country's competitiveness [16]. Another interesting issue is whether chronic stress affects the acute stress response. It may be possible that the acute stress response becomes weaker after chronic stress exposure [17].

Studies have revealed an association of unfavorable stress level with lowered medical students' self-esteem [18], difficulties in solving interpersonal conflicts, increased alcohol and drug consumption[19, 20], anxiety and depression [21], cynicism, decreased attention, reduced concentration and academic dishonesty [22], sleeping disorders [23]. Unfavorable stress was also associated with inhibition of students' academic achievement and personal growth development [18]. As a result, medical students may feel inadequate and unsatisfied with their career as a medical practitioner in the future. Therefore many researchers have stated the importance of early diagnosis as well as effective psychological services, which can prevent possible future illnesses among medical students.

This study includes assessment of stress in medical students and correlation with EEG changes. A stress free medical curriculum is not possible or even desirable because some stress is required for learning. Again within a short period of time they have to complete theory classes of different subjects, clinical classes which include diagnosis of disease and its treatment, associated with emergency duties. So definitely all those events create stress in most medical students. Assessment of stress can be done by many ways. The important quantifying methods include the biosignal channels like EEG, ECG, SCR (Skin Conductance Response) etc. Hormonal assay of blood is also very informative to confirm stress. In this study the simple and noninvasive technique like Self – Report Questionnaire method was used to asses stress in medical students and when stress is suspected it was confirmed and correlated by EEG.

The aim and objective of this study was to find out stress among medical students and to findout the correlation between stress and EEG.

MATERIALS AND METHODS

The study was conducted in the department of Physiology in collaboration with department of Neurology, V.S.S Medical College, Burla, Odisha, India. The study was carried out for a period of one and half year, from December 2011 to June 2013. It is a cross-sectional study in which stress level of a defined population was assessed and how it is related to EEG was observed at a single time interval. Subjects for this study are undergraduate students of V.S.S. Medical College, Burla. 10 students from each academic year, a total of 50 students were randomly selected on questionnaire basis for this study. The study was approved by the Institutional Ethics Committee, V.S.S. Medical College of Sambalpur University, Jyotivihar. For assessment of stress Medical Student Stressor Questionnaire (MSSQ) was used. MSSQ is a validated instrument to identify stressors among

medical students. It comprises of 40 items which are grouped into six domains or stressor groups i.e.

- Academic Related Stressors (ARS)
- Intrapersonal and Interpersonal Related Stressors (IRS)
- Teaching and Learning Related Stressors (TLRS)
- Social Related Stressors (SRS)
- Drive and Desire Related Stressors (DRS)
- Group Activities Related Stressors (GARS)

It is a self-reporting questionnaire and each item represents a particular stressor. The items are rated fewer than 5 categories i.e.0, 1, 2, 3 and 4 to indicate intensity of stress.

Inclusion criteria

Students having stress of any kind in the six domains were included in study the group.

Exclusion criteria

Students suffering from neurological disease or psychiatric disorder or any other diseases were excluded from this study.

Selection of cases

Students were explained regarding the study and a written consent was taken from each student. Questionnaires were distributed among the students and they were instructed to respond to each item by encircling any one number from 0 to 4. The time limit was 15 minutes to fill the MSSQ and then questionnaires were collected from the students. Analyzing those questionnaires 10 students from each academic year, a total of 50 students were selected for this study including both male and female. Then grading of stress was done for each domain by calculating mean domain score. According to MSSQ Manual the degree of stress is divided into 4 categories i.e. mild, moderate, high and severe.

Mild: Indicates that it does not cause any stress on you. Even if it does, it just causes mild stress.

Moderate: Indicates that it reasonably causes stress on you. However you can manage it well.

High: Indicates that it causes a lot of stress on you. Your emotions seem to be disturbed by it. Your daily activities are mildly compromised due to it.

Severe: Indicates that it severely causes stress on you. It disturbs your emotions badly. Your daily activities are compromised due to it.

For each subject one domain may be severe where as other domain may be mild or moderate or high. So the severity of stress of a subject was determined considering the highest degree of stress on any domain out of six.

Mean domain score = Total score of the specific domain divided by total no of items in that domain.

Data about the name, age, sex, height, weight, current academic year, choosing the profession (choice/induced), education of family head, occupation of family head, income of family head and disease history were obtained. Taking account into education, occupation and income of family head socioeconomic status of students was determined by Kuppuswamy's Socioeconomic Status Scale. The original Kuppuswamy's Socioeconomic Status scale was classified as Upper, Upper middle, Lower middle, Upper lower, Lower. But for convenience the scale was modified as Upper, Middle, and Lower. To compare the level of stress, the subjects were classified into following groups

According to gender – Male and Female
According to choosing profession – Induced and Choice group
According to curricular year – Preclinical, Paraclinical and Clinical
According to socioeconomic status – Upper socioeconomic status, Middle socioeconomic status and Low socioeconomic status

Recording of EEG

To correlate stress with EEG subjects were divided into two groups i.e. SWED (Stress With Emotional Disturbance) and SNED (Stress but No Emotional Disturbance). Mild and Moderate stress does not disturb emotion, so included in *SNED* where as High and Severe stress disturb emotion, so included in SWED. EEG recording was done in the department of Neurology by the EEG machine Recorders and Medicare System (P) Ltd. In conventional EEG recording four procedures are followed i.e. eye close, eye open, hyperventilation and photic stimulation. But in this experiment recording was done only in eye close state for a period of 10 minutes for each participant. Finally the EEG waves of both groups were analyzed and how stress and EEG are associated was studied.

Statistical Analysis

Statistical analysis of data was done with the help of software SPSS version 16. Statistical tests used were Mann-Whitney U test, Kruskal Wallis test, Chi-Square Test.

RESULTS

Table 1 and Figure 1 shows the comparision of stress between male and female subjects. The statistical test used was Mann-Whitney U Test. It compares the mean rank of two grouping variables and the mean rank of female is more than male. The p value associates with Mann-Whitney U of 192 is < 0.05 means the difference is significant and females experience more stress than males.

Table 2 and Figure 2 shows the comparision of stress between the subjects who have entered into this profession by choice and induced by parents or others. The statistical test used was Mann-Whitney U Test. It compares the mean rank of two grouping variables and the mean rank of induced group is more than the choice group. The p value associates with Mann-Whitney U of 7 is < 0.001 means the difference is significant and induced group experience more stress than choice group. Table 3 and Figure 3 shows the comparision of stress between these three groups. The statistical test used was Kruskal-Wallis Test. These mean ranks are compared using a form of chi-square test. The p value is greater than 0.05 and the difference in mean rank is not statistically significant. So it can not be said curricular year is associated with difference in level of stress. Table 4 and Figure 4 shows the comparision of stress between three socioeconomic status groups. The statistical test used was Kruskal-Wallis Test. These mean ranks are compared using a form of chi-square test. The p value is less than 0.001 and the difference in mean rank is statistically significant. So there is difference in level of stress between the SES groups. Table 5a, 5b and 5c and Figure 5 show the correlation between stress and EEG. The statistical test used was Chi-Square test. The Chi-Squre value of this cross tabulation of degree of freedom 1 is 20.82 which is much larger than of probability 0.001 (10.83). So the data shown in cross tabulation are significantly different. So Stress With Emotional Dsturbance (SWED) showing beta wave and Stress but No Emotional Disturbance (SNED) showing alpha wave is true. Table 15c shows contigency coefficient that measures the association between stress and eeg waves. The p value is less than 0.001 and it signifies that Beta wave is associated with SWED whereas alpha wave is associated with SNED.

Grouping Variables	n	Mean Rank	Sum of Ranks	Mann-Whitney U (stress)	Z	P (2 tailed)
Male	29	21.62	627	192	-2.21	0.027
Female	21	30.86	648			

Table 1: Comparison of stress between male and female subjects

Grouping Variables	n	Mean Rank	Sum of Ranks	Mann-Whitney U (stress)	Z	P (2 tailed)
Choice	22	11.82	260	7	-5.88	0.000
Induced	28	36.25	1015			

Table 2: Comparision of stress between groups choosing the profession

Grouping variables	n	Mean Rank	Kruskal-Wallis Chi-square	df	p
Preclinical	10	24.9	2.1	2	0.349
Paraclinical	20	22.32			
Clinical	20	28.98			

Table 3: Comparision of stress between subjects of curricular year

Group variables	n	Mean Rank	Kruskal-Wallis Chi-square	df	p
USES	14	12.32	18.59	2	0.000
MSES	16	26.19			
LSES	20	34.18			

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Table 4: Comarision of stress between Socioeconomicastatus groups

a

			EEG		
			ALPHA	BETA	Total
Stress	**SWED**	Observed Count	2	25	27
		Expected Count	9.7	17.3	27.0
	SNED	Observed Count	16	7	23
		Expected Count	8.3	14.7	23.0
Total		Count	18	32	50
		Expected Count	18.0	32.0	50.0

b

Contigency Coefficient	p
0.542	0.000

c

Chi-Square	df	p
20.82	1	0.000

Table 5 (a,b,c): Correlation between Stress and EEG

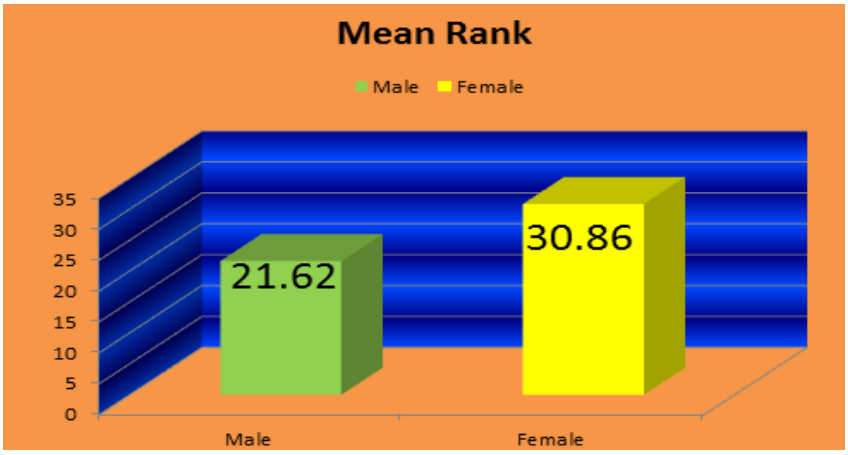

Figure 1: Comparison of stress between male and female subjects

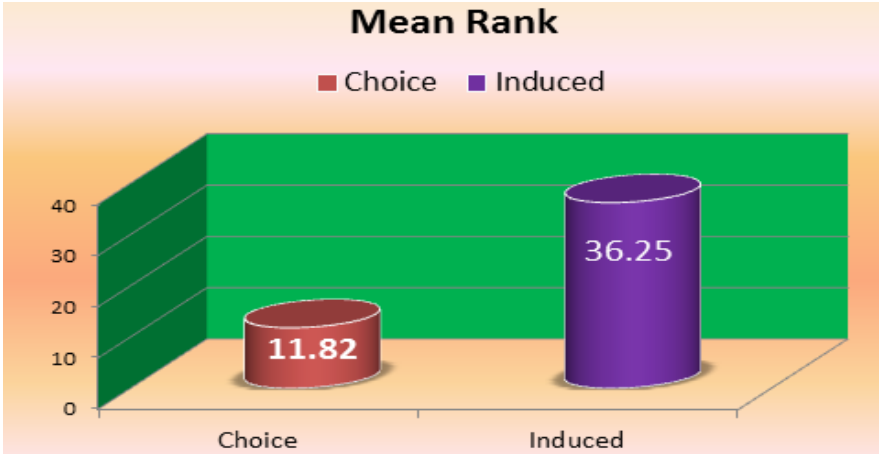

Figure 2: Comparision of stress between groups choosing the profession

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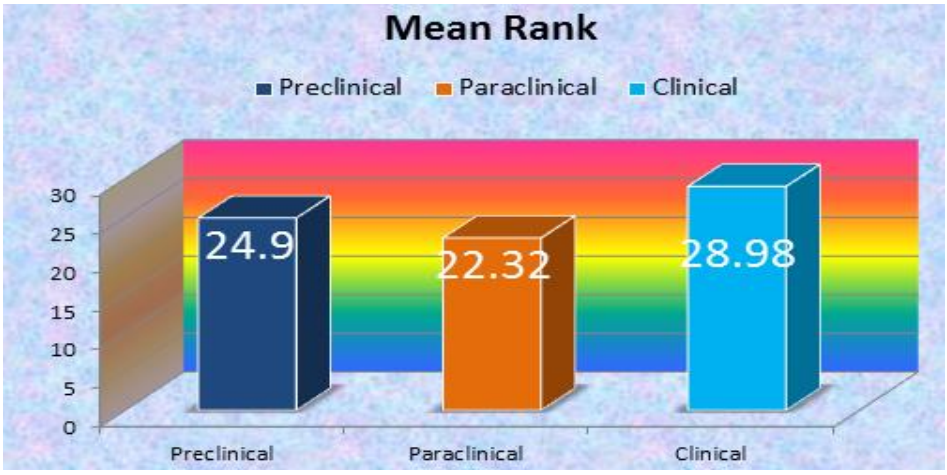


Figure 3: Comparision of stress between subjects of curricular year

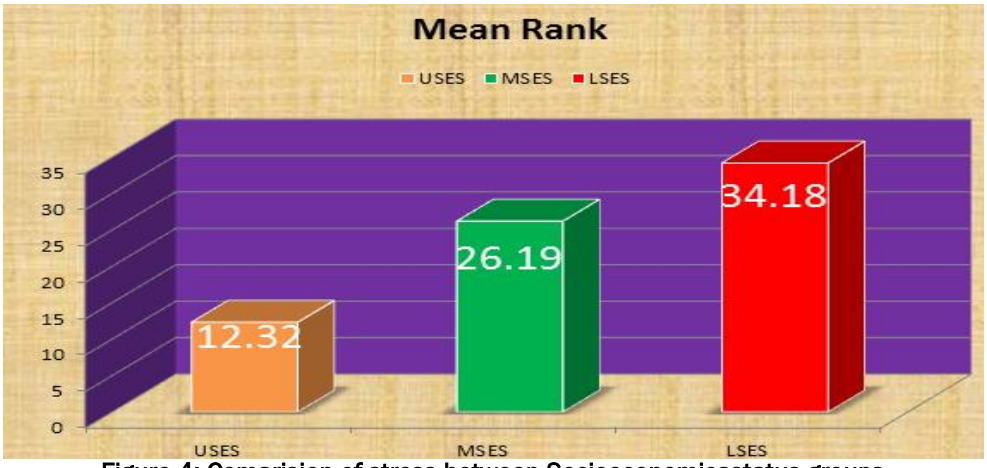
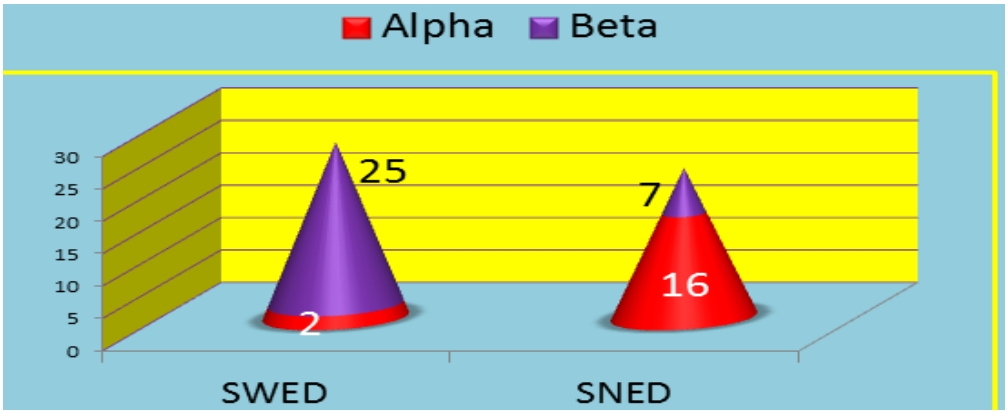


Figure 4: Comarision of stress between Socioeconomicastatus groups

Figure 5: Correlation between Stress and EEG



DISCUSSION

Medical curriculum is highly stressful. The cause may be mismatching of time and academic career or other associated factors like social factors, socioeconomic status of parents, choosing profession etc. A stress free medical curriculum is not possible or even desirable because some stress in medical school training is also needed for learning [42]. A

lot of research has been undertaken in assessment of stress and emotion over the last years. Beside the release of cortisol (stress hormone), stress can be quantified from human bio-signals such as EEG, Electrocardiogram (ECG), Electromyogram (EMG), Galvanic Skin Response (GSR), Blood Volume Pulse (BVP), Blood Pressure (BP), Skin Temperature (ST) and Respiration. Most previous researches, have investigated the use of EEG and peripheral signals separately, but little attention has been paid so far to the fusion between EEG and peripheral signals.

This study includes *Assessment of stress and correlation with EEG in medical students*. EEG shows alteration of different waves in stress condition.

In this study it is found that female medical students suffer from more stress than male students significantly. Dahlin M et al [24] in a cross sectional study on "Stress and depression among medical students" found that female medical students were suffering from more stress than male medical students. Towes JA et al [25] also studied "stress among residents, medical students and graduate science students" and found that female students and residents were suffering from more stress than male students and residents. So this study correlates with the result of previous study by Dahlin M et al [24] and Towes JA et al [25]. Female students are more concerned regarding ARS, SRS and GARS in this study which may be the possible cause of more stress experienced by them.

Among these subjects some have entered into this profession by choice and others by motivation induced by parents or some other persons. There was a significant difference in experience of stress between these two groups of subjects' i.e. by choice and induced. The induced group has experienced more stress in comparison to choice group. G.M. Koochaki et. al. [26] done a cross sectional study on "Prevalence of stress among Iranian medical students" and came to a conclusion that, the students joined this profession by motivation, experienced more stress than the students entered by choice. In this research it is found that induced group subjects have more stress towards DRS. They are not interested in this curriculum but entered to this curriculum as induced by others or to fulfill the wish of their parents. This unwillingness or lack of interest towards the medical curriculum may be the possible cause of stress.

In this study it was found that, there was no significant difference in level of stress between Preclinical, Para clinical and Clinical year students. G.M. Koochaki et. al [26] did a research on stress among medical students and compared the level of stress among preclinical, paraclinical and clinical year students. He found no significant difference in the level of stress among these three phases of study. Therefore the result of this study is correlated with the study of G.M. Koochaki et al. These different phases of study are stressful in different ways. In preclinical year there is stress of coping with a new course, adjusting to the demands of high academic work load and fears of lagging behind. In Para clinical and Clinical Years the stress may be due to dealing with patients, diagnosis of disease, suffering of patients, etc.

Parents' Socioeconomic status has a direct influence on their children's occupational attainment and has been found to be the most powerful and consistent predictor of achievement and career aspirations (Hill NE, Castellino DR, Lansford JE, Nowlin P, Dodge KA,

Bates JE, et al) [27]. This study showed that, there is a significant difference in stress between subjects of USES, MSES and LSES. LSES subjects experience more stress than other two groups. Similar result was found by Angela PC Fan[28] in his study "The Association Between Parental Socioeconomic Status (SES) and Medical Students' Personal and Professional Development". Kohn [29] suggested that children from a lower social class are brought up in an atmosphere that encourages a "conformist orientation" without the flexibility necessary to deal with stressful situations. Other impacts of low SES suggested by previous researchers include lower self-esteem, blocked aspirations, status frustrations, impaired efficacy, fatalism and lower mastery and personal control (Eaton WW) [30].

Emotions are part of any natural communication between humans, generally as non-verbal cues. Emotion is psychology condition, which affects the central nervous system. In recognition of emotions, brain activity plays a central role. Stress is caused by human resistance towards new challenges or stressors (stress factors) emotionally, mentally or physically. In other word, stress causes the imbalance of sympathetic and parasympathetic response in human Autonomous Nervous System (ANS). Among these bio-signals, the changes in ANS due to stressors can be apparently and effectively represented by EEG signals. Researchers have reported the characteristic change of EEG signals due to the change of human cognitive states after performing some mental tasks. Stressors such as noisy working area, high workload, unfinished job, improper sleep and family conflict can also alter EEG signals.

Result of this study indicates that stress with emotional disturbance (SWED) is associated with beta wave on EEG and stress but no emotional disturbance (SNED) is associated with alpha wave on EEG. According to "Review of Medical Physiology" Ganong: awake but at rest with mind wandering and eyes closed, the wave is alpha wave (23rd edition Ganong) [31].

Papanicalaou et al [32] did a study on Task-related EEG asymmetries: a comparison of alpha blocking and beta enhancement and got found that there is an inverse relationship between alpha and beta wave in stress. Beta activity increases when processing demands increases. Niemic CP [33] in his study "A theoretical and empirical review of psychophysiological studies of emotion" confirmed that increased alpha activity is an indication of brain inactivity while decreased alpha activity is an indication of greater brain activity.

When the awake person's attention is directed to some specific type of mental activity, the alpha waves are replaced by asynchronous beta waves. These findings suggest that beta waves generally reflect increased excitatory activity, particularly during diffuse arousal and focused attention [34].In subjects of SWED attention is focused on something and their mind is in alert state. So the normal alpha activity was replaced by an irregular low voltage beta rhythm of frequency 13 -30 Hz. This phenomenon is known as alpha block.

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