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ORIGINAL ARTICLE

Investigation of QEEG Waves on Depression and Anxiety: A Systematic Review

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ABSTRACT

This study aims to examine the evaluation of brain waves through Quantitative Electroencephalography in diagnosing and treating depression and anxiety. For this purpose, the keywords "depression, anxiety, QEEG" were scanned in national and international databases. First, all abstracts, titles, and articles in electronic databases were examined, and 181 studies published between 1988-2021 were reached. According to the PRISMA criteria, the articles included in the research were examined by the systematic review method. Five studies were examined due to the evaluation made due to the research. Inclusion criteria in research; It was determined that the studies were between 1988-2021 and included the keywords "depression, anxiety, QEEG". Exclusion criteria were determined as unofficial websites, newspapers, and conference proceedings. According to the results obtained in the study, it was concluded that Quantitative Electroencephalography is an important method used in the diagnosis and treatment of depression and anxiety, which represents the distribution of waves of different frequencies on the brain by analyzing the electrical activity record taken from the scalp, and thus provides indirect information about the functioning of the brain. It is suggested that the research results must be supported by experimental studies with experimental and control groups.

Keywords: Depression, Anxiety, Quantitative Electroencephalography, Brain Waves

INTRODUCTION

The EEG application, which is used to measure the waves broadcast at different frequencies in the brain, is performed by placing metal electrodes on certain areas of the skin. The placement of these electrodes is shown in Figure 2. As a result of EEG application, the intensity and type of waves are measured. Thus, brain activity is measured and recorded (Budzynski, Kogan, Evans, & Abarbanel, 2009). It has been known since 1929 that the human brain produces electricity. Detection and recording of these activities are provided by placing electrodes on the scalp in the head area. The data collected from these electrodes are recorded in the computer environment between fifteen and thirty minutes. Contrary to the misconception in society, there is no electrical current transmission from the electrodes to the skin. The individual does not feel any pain. It is a non-invasive procedure. The patient should be comfortable, eyes closed, jaw and neck muscles should be kept relaxed, and the patient should be kept as still as possible during the procedure so that the received signals do not cause noise (interference). Otherwise, artifacts may occur. In the first three minutes of the twenty-minute procedure, the patient is asked to take a deep breath. Afterwards, the individual is given a light stimulus at certain intervals and brain responses are observed (Turner, 2020, p.126). Classification of brain waves is made according to the number of signal waves detected in one second (Knab, Bowen, Hamilton, Gulledge, & Lightfoot, 2009, p.147).

1 to 3 Hz. The wave type between frequencies is called delta. This wave occurs on average 1 to 3 times per second; it is the lowest wave in terms of frequency of occurrence. It usually occurs in newborns in the third and fourth stages of sleep. Theta is a type of wave that indicates "slow" motion that occurs on average 3.5 to 7.5 times per second, and therefore between 3.5 and 7.5 Hz. Such waves are sometimes called "dream" waves. It usually occurs while experiencing prayer, meditation, dreams, and emotional moments. Alpha, which occurs on average 7.5 to 13 times per second, is 7.5 to 13 Hz. It is a type of wave that stands between and expresses calmness. This wave is mostly seen in the occipital lobe of the brain. Beta, which averages 14 to 36 times per second, is 14 to 36 Hz. It is a wave that indicates a state of rapid activity, alertness, or tension. This wave is most perceived from the front of the head. Low Beta, which occurs on average 12 to 15 times per second, is 12 to 15 Hz. The type of wave shows the focus, being balanced and comfortable. This wave is also called SMR (Sensory Motor Rhythm) and occurs most often in the side of the head and lobe.

Physiological measurements have become more accurate with the development of computer technology, and they have been evaluated according to rapidly developing standards and databases in terms of specificity and comparability. Quantitative Electroencephalography (QEEG) is a method used to examine brain waves that include computers and power spectral analysis of brain waves (Thatcher, 2010, p.122). This method differs from the traditional or visual analysis commonly used by neurologists to detect brain waves. QEEG is a method of analyzing the brain's electrical activity by deriving quantitative models that can correspond to diagnostic information and cognitive deficits. In QEEG, brain waves are recorded and analyzed in the frequency spectrum using a mathematical technique called the "Fourier transform". The strength and dominance of each brain frequency are calculated separately. However, the reliability and validity of QEEG are over 90%, and it is widely used in clinical settings (Thatcher, 2010, p.152).

QEEG feedback provides access to information that will change clients' lives in the development of databases and protocols that compare actual measurements with these database norms (Budzynski et al., 2009). Brain maps provide vital information that shows which parts of our brain are more active or less active. Based on brain wave activity

represented in certain brain areas, QEEG can detect anxiety, depression, seizures, epilepsy, head injuries, brain tumor, sleep problems, memory problems. In addition, with the arrangements made with Loreta for QEEG analysis, it can be seen in which region of the brain Delta waves are concentrated. Normally, waves, especially those coming from the lower muscles of the brain, are unlikely to be taken from where in the brain. By arranging waves with Loreta, new wave zones are organized. Loreta inversion power data analysis shows that significant group differences emerge after correction for multiple comparisons, mainly in the delta band located in the temporal posterior regions. Before adjusting for multiple comparisons, significant differences in the delta band distributed over the entire scalp appear to spread over the surface.

Depression and anxiety are different conditions, but they often occur together. There are also similar treatments. It's normal to feel down or sad from time to time. Everyone feels anxious from time to time. It is a normal response to stressful situations. However, severe or ongoing feelings of depression and anxiety may indicate an underlying mental health disorder (Miller & Massie, 2006).

Anxiety can occur as a symptom of clinical (major) depression. It's also common to have depression triggered by an anxiety disorder, such as generalized anxiety disorder, panic disorder, or separation anxiety disorder. Many people have a diagnosis of both anxiety disorder and clinical depression. Symptoms of both conditions can often be treated with psychotherapy, medications such as antidepressants, or both. In this process, QEEG can be used to observe brain function changes and provide an effective treatment. QEEG information can be interpreted and used by experts as a clinical tool to assess brain function and monitor changes in brain function due to various interventions such as neurofeedback or medication (Lee, Yu, Chen, & Chen, 2011).

In clinical practice, the combined use of surface and functional electromagnetic neuroimaging QEEG provides important additional clinical and neurophysiological information. QEEG is a non-invasive, inexpensive, portable technique with high temporal resolution (milliseconds) and improved spatial resolution (up to 3 mm3) and is a viable and validated tool for investigating abnormal brain dynamics and interconnection of neuronal networks in clinical disorders of the brain. Clinical QEEG is an applied clinical tool that helps evaluate various neurological and psychiatric disorders (Koberda, Moses, Koberda, & Koberda, 2013, p.273). Considering the national studies, there are limited studies with QEEG. Therefore, in this study, the evaluation of brain waves using Quantitative Electroencephalography was examined to diagnose and treat depression and anxiety.

MATERIAL AND METHOD

In this study, articles published between 1988-2021 in the PubMed database were searched to examine QEEG waves on depression and anxiety. This study analyzed the scanned publications with the systematic review method.

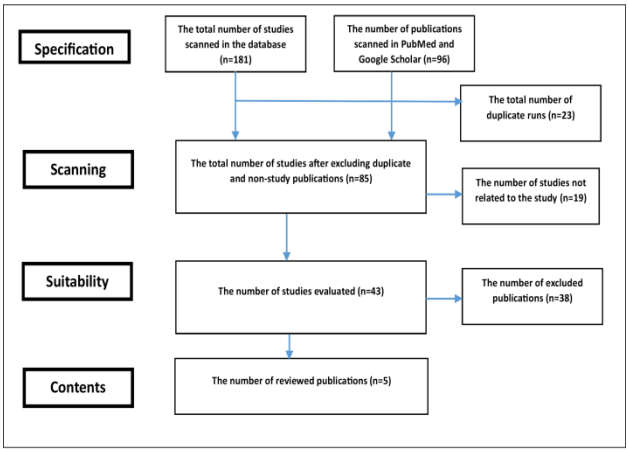

Fig. 1: Presentation of the process of inclusion of studies in the systematic review in PRISMA format

Table 1: Characteristics of Studies Analyzed in the Research

Research	Sample Characteristics	Measuring Tools	Results
Mirski, A., Pąchalska, M., Moskała, M., Orski, M., Orska, M., Miąskiewicz, M., … Kropotov, J. (2015).	A 45-year-old woman suffering from anxiety	QEEG.	After the intervention, the QEEG frontal asymmetry pattern and excessive temporal P1 wave were normalized.
Markovska-Simosa, S., Pop-Jordanova N., and Pop-Jordanov, J. (2018).	10 participants with general anxiety and depression disorder	QEEG data has been used and reported. All measurements were made under two conditions: eyes open (EO) and eyes closed (EC).	As a result of the analysis, the results of the scale and the QEEG results were found to be compatible.
Lee, T. W., Yu, Y. W.-Y., Chen, M. C., and Chen, T. J. (2011).	196 depressed participants	QEEG	QEEG analysis results found that somatic anxiety and delusions produce different brain waves.
Roh, S. C., Park, E. J., Shim, M., and Lee, S. H. (2016).	73 participants with major depressive disorder	QEEG	Beta (12-30Hz) and low gamma (30-50Hz) activities in the frontocentral regions were negatively correlated with inattention scores.
Grin-Yatsenko, V. A., Baas, I., Ponomarev, V. A., and Kropotov, J. D. (2010).	111 depressed and 526 non-depressed participants	Spectral characteristics of QEEG, ICA and sLORETA	An increase in slow (theta and alpha) activity in the parietal and occipital regions in depressed patients may reflect decreased cortical activation in these brain regions, and it was concluded that the widespread increase in the beta wave is associated with symptoms of anxiety, which plays an important role in the onset of depressive disorder.

A systematic review reviews a clearly defined problem using systematic, clear methods to identify, select, and critically evaluate relevant research and collect and analyze data from studies included in the review (Millar, 2004). In the review, the keywords "depression, "anxiety", "QEEG" were scanned electronically. First, all abstracts, titles, and articles in electronic databases were examined, and 181 studies were reached. In the studies reached, five studies were examined. This systematic review; was conducted in line with the "Centre for Reviews and Dissemination 2006" guide developed by the National Institute of Health Research at York University (Dixon-Woods, Bonas, Booth, Jones, Miller, Sutton, & Young, 2006, p.27).

Inclusion criteria in the review; It was determined that the studies were between 1988-2021 and included the keywords "depression, "anxiety", "QEEG". Exclusion criteria were determined as unofficial websites, newspapers, and conference proceedings.

RESULTS

In this section, a systematic review of the evaluation results of brain waves through QEEG in the diagnosis and treatment of depression and anxiety (Table 1) is given.

All the studies included in the research were published between 1998-2021. QEEG was used as a measurement tool in all studies. Mirski et al. (2015) used QEEG measurements before and after depression in a 45-year-old woman with depression. According to the QEEG results, a 45-year-old woman with a frontal asymmetry pattern and excessive temporal P1 wave returned to normal after the intervention.

In a study by Markovska-Simosa, Pop-Jordanova, and Pop-Jordanov (2018), scale and QEEG were compared. As a result of the analysis, the results of the scale and the QEEG results were found to be compatible. For depressed and anxious patients, decreased intrahemispheric coherence was found for the eyes-open condition for delta brain waves throughout the cortex. The results obtained in the study are shown in Figure 2. Hypo-consistency in the -parietal-occipital region for the interhemispheric delta in anxiety patients and lower delta through the cortex in the intrahemispheric was achieved. Findings of hyper-interhemispheric fit in depressed subjects, especially for alpha and beta bands, have been confirmed in other studies. It was concluded that QEEG consistency analysis is a sensitive parameter in detecting electrophysiological abnormalities in patients with anxiety and depression. These results confirm the development of QEEG state and trait biomarkers for psychiatric disorders.

Lee, Yu, Tai-Jui Chen, and Ming-Chao Chen (2011) studied higher symptom severity of somatic anxiety, higher regional energy over common cortical regions, and lower energy in bi-temporal, temporoparietal, and frontoparietal connections. Found to be associated with As seen in Figure 4, QEEG analysis results produce different brain waves of somatic anxiety and delusions. This finding reflects the hallmark of psychiatric disorders with QEEG. In another study, a negative correlation was found between beta (12-30 Hz) and low gamma (30-50 Hz) activities and inattention scores in the frontal central regions. Therefore, it was concluded that high scores strongly predicted inattention scores (Roh, Park, Shim, & Lee, 2016, p.124).

In a comparative study conducted by Grin-Yatsenko, Baas, Ponomarev, and Kropotov (2010), depressed patients were compared with healthy participants. According to the results obtained, significant differences were found between the groups for three frequency bands theta (4-7.5 Hz), alpha (7.5-14 Hz), and beta (14-20 Hz). Theta (4-7.5 Hz), alpha (7.5-14 Hz), and beta (14-20 Hz) were evaluated in both Eyes-closed and Eyes-open conditions in the study. An increase in slow (theta and alpha) activity in the parietal and occipital regions in depressed patients may reflect decreased cortical activation in these brain regions, and it was concluded that the widespread increase in the beta wave is associated with symptoms of anxiety, which plays an important role in the onset of depressive disorder. The gray color in the amplitude spectrum indicates areas with statistically significant differences between depressed and healthy participants.

Considering the results of this research, QEEG is a valuable biomarker in evaluating neurophysiological changes and detecting mental status (Lee, Jang, & Chae, 2017, p.316). Mirski, Pąchalska, Moskała, Orski,Orska, Miąskiewicz, and Kropotov (2015) suggested that QEEG-derived frontal alpha asymmetry is a biomarker for depression. Cook, Hunter, Korb, and Leuchter (2014) suggested that theta activity, especially in the midline frontal location, reflects brain dysfunction in depression or anxiety disorder patients. According to Markovska-Simosa, Pop-Jordanova, and Pop-Jordanov (2018), they reported that they confirmed the development of QEEG status and trait biomarkers in patients with psychiatric disorders such as anxiety, depression, etc. In the future, it is hoped that with the aid of consistent results, evidence of normal or abnormal network activity in psychiatric patients can be confirmed.

CONCLUSION

When QEEG is repeated after treatment, it can show the positive change achieved with treatment. As can be understood from the profiles obtained before and after the treatment in the samples, it can be observed with the bioelectrical activity recording that the treatment corrects the irregularity in the brain chemistry. Because many mental disorders are brain diseases, it is important to understand and monitor brain function for effective treatment. In the treatment of depression, it is important to monitor the biological dimension and the psychological or social dimension in cases that are resistant to treatment. It is aimed to diagnose and treat by measuring brain functions in adults, adolescents, and children.

It is possible to measure with QEEG, the product of biological processes in the brain. Numerous validity and reliability studies have been conducted on this subject. QEEG It has been reached as a result of the research that it is among the most usable methods among the existing biological indicators. This research was organized as a systematic review. It is recommended to support the research results with experimental studies and experimental and control groups.

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