

## A Comparative Study of EEG Abnormalities among Subjects with Inter-Ictal Psychosis and Those with Schizophrenia

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### ABSTRACT

**Background:** Electrophysiological investigation is an integral part in the management of neuropsychiatric disorders; but this is rare in developing countries including Nigeria.

**Objectives:** The study aims to determine EEG abnormalities among subjects with inter-ictal psychosis in comparison to those with schizophrenia.

**Methods:** A cross-sectional study of subjects with inter-ictal psychosis and those with schizophrenia. Each of the subjects that met the inclusion criteria had an awake EEG recording that lasted 45 minutes.

**Results:** For PWEIP, the mean age was 23.9 ( $\pm$ 13.8) years; and made up of 53 (53.0%) males; and for PWS, the mean age was 24.2 ( $\pm$ 13.5) years; and there were 51 (51.0%) males. The EEG was normal in 53 (53.0%) of PWEIP and in 83 (83.0%) of PWS.

EEG was abnormal in 47 (47.0%) of PWEIP, and 17 (17.0%) in those with PWS, and these were all 'epileptiform' activities, and the difference was statistically significant with  $X^2=20.7$  (Fisher's exact test),  $df=1$  and  $p=0.00^{**}$ .

**Conclusion:** A number of subjects in our sample with inter-ictal psychosis and PWS had EEG epileptiform activities reflecting cerebral insults in early life. Thus, preventive measures such as good antenatal care are advocated to minimize the occurrence of these neuro-psychiatric disorders.

**Keywords:** EEG abnormalities, inter-ictal psychosis, schizophrenia.

**E**pilepsy is one of the commonest chronic neurological disorders. Particularly in developing countries, a number of insults to the brain increase the risk of developing epilepsy. The diagnosis still largely remains personal history and eye witness account; however Electroencephalography (EEG) is an important investigation in the field of epileptology<sup>1-4</sup>. Furthermore, it is generally agreed that the incidence of psychiatric disorders is higher in patients with epilepsy than in the general population<sup>5</sup>; and studies have shown that estimated 20-30% of persons with epilepsy (PWE) have such

psychiatric disturbances; and the most common are depression, anxiety and psychoses<sup>6</sup>. For psychoses in PWE, the risk is estimated to be 6-12 times that of the general population, with a prevalence of about 7-8%. Vuilleumier and Jallon (1998) found that 2-9% of PWE have psychotic disorders, and about half of such psychotic cases could be diagnosed with schizophrenia-like disorder<sup>7</sup>.

On the other hand, schizophrenia is one of the commonest psychotic disorders, most especially among hospitalized psychiatrically-ill patients. For some time now, schizophrenia is considered a pathology in the continuum of developmental spectrum disorders. In comparative studies, Stagno reported that persistent interictal psychoses of epilepsy and the schizophrenia-like psychosis of epilepsy are distinguishable from schizophrenia by the following: lack of negative symptoms of schizophrenia, better premorbid personality, paranoid delusions, delusions of reference, and more benign and variable course<sup>8</sup>. Furthermore, abnormalities have been reported in epilepsy-related psychoses and

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schizophrenia, and there are converging lines in neuro-imaging and neuropathology implicating the mesial temporal structures, more so in the dominant hemisphere<sup>9</sup>.

EEG is still one of the most important investigative tools in the field of epileptology. It is especially useful to localize seizure focus, and can be used to distinguish true from pseudo-seizure. On the other hand, for many years, EEG was a vital investigation in psychiatry; but with the advent of neuro-imaging techniques, there was a decline in EEG use in psychiatry; and is particularly used mainly in the investigation of sleep and sleep disorders<sup>10,11,12</sup>. However, over the past few decades, and especially with the findings of many neuro-pathological changes in the brains of persons with schizophrenia (PWS), and the neuro-developmental theories of schizophrenia, EEG is now utilized again in the investigation of schizophrenia; although to a limited extent compared with modern neuro-imaging techniques<sup>13,14,15</sup>. For subjects with epilepsy-related psychoses, laboratory studies have shown bilateral EEG discharges are seen more often in such subjects than non-psychotic controls<sup>16</sup>.

In Nigeria and the West African sub-region, a number of studies have been carried out on inter-ictal EEG abnormalities among persons with epilepsy (PWE)<sup>4,9,10</sup>; but to the best knowledge of the authors, no published work has been done on EEG abnormalities in Persons with Epilepsy and Inter-ictal Psychosis (PWEIP). Thus, this study sets out to find EEG abnormalities in patients with epilepsy and inter-ictal psychosis compared to those with schizophrenia.

#### **MATERIALS AND METHODS:**

The study was carried out in the EEG unit of the Federal Neuropsychiatric Hospital (FNPH), Yaba, Lagos. The hospital is over one hundred years old with about 530 bed spaces. It is one of the foremost mental health facilities in the West African sub-region. The main hospital is located in Yaba, Lagos, with a big annexe in Oshodi, about two kilometers away from Yaba. The EEG unit was established in the hospital in the year 2001.

It is one of the centres in Nigeria with pioneer modern Digital EEG machines in the country. Patronage is from the study centre, other health facilities in Lagos and from other distant states in the country.

#### **Subjects and Study Design:**

The study is a comparative cross-sectional study among persons with epilepsy and inter-ictal psychosis (PWEIP); and age and sex-matched persons with schizophrenia (PWS) that were referred for electroencephalographic (EEG) recording investigation in the study centre.

For Persons with Epilepsy and Inter-ictal Psychosis (PWEIP), the diagnosis of Epilepsy was made through an eye witness account of at least three episodes of seizure within the last twelve months before commencing the study. Furthermore, there should be presence of inter-ictal psychosis. The definition of interictal psychosis in this study is as follows: One, psychosis is defined as the presence of hallucinations, delusions and behaviours not in contact with realities of life. Two, the operational criteria for interictal psychosis were: the psychosis developed at least after a year of the onset of epilepsy, the psychotic episodes are between seizure occurrences, psychotic episodes lasting 24 hours or more in a state of full consciousness; and lastly the typology could be schizophrenia-like psychosis (at least one episode lasting for one month or more) or brief psychosis (episodes resolve within one month)<sup>17,18,19</sup>.

For the comparative group of subjects with schizophrenia, the diagnosis of Schizophrenia was usually made by the Resident Doctors and confirmed by the Consultant Psychiatrist in line with the diagnostic criteria of International Classification of Diseases, 10<sup>th</sup> version (ICD-10)<sup>20</sup>.

Subjects were recruited from consecutive persons with these diagnoses presenting in the study centre (the EEG Unit of FNPH, Yaba, Lagos). A convenient sampling method was used whereby persons with the diagnoses and meeting the inclusion criteria were consecutively recruited until a sample size of 100 was obtained for each of the two diagnostic groups (PWEIP and PWS).

**Ethical Consideration:**

Necessary ethical approval was obtained from the Research and Ethics Committee of the hospital to carry out the study. Necessary consent was also obtained from the subjects and/ or caregivers before been included in the study. Confidentiality was assured on the data obtained.

**Procedure:**

For each subject selected for study, a Socio-demographic and Clinical Profile Questionnaire was administered to obtain necessary data such as age, sex, clinical diagnosis, duration of illness etc.

Thereafter, each of the subjects had an awake EEG recording that lasted 45 minutes. Necessary activation method, usually over breathing exercise for 3 minutes was carried out by each subject during the EEG recording so as to increase the yield of any possible EEG abnormalities.

The EEG tracing for each subject was interpreted by one of the researcher, OFA. One third of the EEG tracings was picked at random for re-interpretation by another independent electrophysiologist as part of quality assurance of the study. The EEG reporting was in line with EEG classification by Ludas and Noachter (2000). Slow background EEG rhythm, as well as intermittent or continuous generalized, lateralized or regional slowing were categorized as nonspecific EEG changes. Spikes, polyspikes, sharp waves, spike/polyspike-and-wave complexes were classified as epileptiform activities<sup>21,22</sup>. When present, the localization and lateralization of these EEG abnormalities were also noted.

**Data Analysis:**

Data obtained from each subject was appropriately coded and entered into Statistical Package for Social Scientists (SPSS) software for necessary analysis. Data summary was presented in tables and proportions. Mean, standard deviation etc were carried out on continuous variables; while chi-squared statistics was carried out on categorical variables. Analysis of variance (ANOVA) statics including regression analysis was used to compare the two groups.

**RESULTS:****Socio-demographic and Clinical Profiles:**

Each group of study, that is PWEIP and PWS was made up of 100 subjects.

For PWEIP, the mean age was 23.9 ( $\pm$ 13.8) years; and made up of 53 (53.0%) males and 47 (47.0%) females. For the comparative group of PWS, the mean age was 24.2 ( $\pm$ 13.5) years; and there were 51 (51.0%) males and 49 (49.0%) females. For the two groups, there was no statistically significant difference in the age and sex of the subjects. Both groups were predominantly young populations. The highest age group was 21-30 years, that is 31 (31.0%) for each study group, closely followed by 11-20 years age group, that is 29 (29.0%) for PWEIP and 30 (30.0%) for PWS. Overall, subjects aged  $\leq$ 30 years made up 75 (75.0%), that is three-quarter of PWEIP; and the same proportion for PWS (Table I).

The mean duration of seizure for PWEIP was 5.6 years; and mean duration of illness for PWS was 2.7 years before presentation for treatment. For PWEIP, the highest number, 32 (32.0%) presented for treatment at one year, closely followed by those that presented  $>$ 5 years after onset of illness, 30 (30.0%). For PWS, those that presented for treatment within 6 months of the onset of illness constituted the highest of 42 (42.0%), and this was followed by those that presented at one year, 22 (22.0%).

**Electroencephalographic (EEG) Findings:**

For PWEIP, the EEG was normal in 53 (53.0%), but for PWS, it was 83 (83.0%). For both groups combined, normal EEG was recorded in 136 subjects (68.0%).

For both groups of PWEIP and PWS combined, the EEG was abnormal in 64 (32.0%) subjects, and were nearly all 'epileptiform' activities (63, that is 31.5%). Specifically, EEG was abnormal in 47 (47.0%) of PWEIP, with 46 (46.0%) been 'epileptiform' activities and 1 (1.0%) had non-specific burst slow activities. For those PWS, EEG was abnormal in 17 (17.0%) of them, and these were all 'epileptiform' activities (Table 2). The difference between the two groups for the presence of EEG abnormalities was statistically significant with

Table (1): Age and sex distribution of subjects

Age Group (years)	PWEIP (%)	PWS (%)	SUBTOTAL (%)
0-10	15 (15.0)	14 (14.0)	29 (14.5)
11-20	29 (29.0)	30 (30.0)	59 (29.5)
21-30	31 (31.0)	31 (31.0)	62 (31.0)
31-40	14 (14.0)	14 (14.0)	28 (14.0)
41-50	6 (6.0)	6 (6.0)	12 (6.0)
51-60	3 (3.0)	3 (3.0)	6 (3.0)
>60	2 (2.0)	2 (2.0)	4 (2.0)
Total	100 (100.0)	100 (100.0)	200 (100.0)
Sex			
Male	53 (53.0)	51 (51.0)	104 (52.0)
Female	47 (47.0)	49 (49.0)	96 (48.0)
Total	100 (100.0)	100 (100.0)	200 (100.0)

$X^2=20.7$  (Fisher's exact test),  $df=1$  and  $p=0.00^{**}$ .

#### Localization and Lateralization of 'Epileptiform' Activities:

The epileptiform activities occurred in 'bursts' in 27 (27.0%) of PWEIP, and 8 (8.0%) of PWS. This was followed by 'Fronto-temporal' region in 7 (7.0%) of PWEIP and 6 (6.0%) of PWS, 'Frontal' in 6 (6.0%) of PWEIP and none (0.0%) for PWS; and for 'Temporal' in 3 (3.0%) of PWEIP and 1 (1.0%) of PWS. Lastly, focal plus burst epileptiform activities were present in 4 (4.0%) of PWEIP and 2 (2.0%) of PWS (Table 3). The difference in localization for epileptiform activities in the two groups (PWEIP and PWS) was statistically significant ( $X^2=24.7$ ,  $df=5$  and  $p=0.00^{**}$ ).

On lateralization in both groups combined; for subjects with focal epileptiform activities, the abnormalities were localized over the right hemispheres in 6 (3.0%), and over the left hemisphere in 5 (2.5%) subjects. The abnormalities were bilateral in 53 (26.5%) of

the subjects, made up of 'bursts', 'bilaterally focal' and those with 'focal and secondary generalization' (Table 3). The difference in lateralization for epileptiform activities in the two groups (PWEIP and PWS) was statistically significant ( $X^2=21.4$ ,  $df=4$  and  $p=0.00^{**}$ ).

#### DISCUSSION:

In our study, both groups were predominantly young population with age groups 11-20 and 21-30 years constituting over 60% of the subjects. Epilepsy and schizophrenia continue to be common neuropsychiatric disorders among adolescents and young adults in developing countries majorly due to numerous cerebral insults in early childhood such as intracranial infections, severe birth asphyxia etc; and thus our findings are also in agreement with previous studies in Nigeria<sup>11,23</sup>.

Both epilepsy and schizophrenia are nowadays considered as continuum pathologies in the spectrum of developmental

Table (2): Distribution of EEG findings (normal and abnormal activities).

EEG Findings	PWEIP (%)	PWS (%)	SUBTOTAL (%)
Normal EEG	53 (53.0)	83 (83.0)	136 (68.0)
Abnormal EEG			
Epileptiform Activities	46 (46.0)	17 (17.0)	63 (31.5)
Non-Specific burst slow activities	1 (1.0)	0 (0.0)	1 (0.5)
Total	100 (100.0)	100 (100.0)	200 (100.0)

$X^2=20.7$  (Fisher's exact test),  $df=1$ ,  $p=0.00^{**}$ .

disorders; thus the finding of ‘epileptiform activities’ in significant numbers of subjects with these pathologies. However, in our study, more PWEIP (46.0%) had ‘epileptiform’ activities compared to PWS (17.0%), and the difference was statistically significant ( $p=0.00^{**}$ ). Epilepsy is not only the highest reason for EEG referrals but also compared with other disorders, it is the pathology in which ‘epileptiform activities’ are mostly found on EEG investigation<sup>24,25,26</sup>.

Again, in our study, the finding of ‘epileptiform activities’ in 17.0%, that is almost one-fifth of PWS is very important, despite this figure been much lower than that of 38.8% in an earlier similar study by Shrivastava et al (2014)<sup>15</sup>. Many studies in the past have shown that compared with apparently healthy population, there is significant EEG abnormality among patients with schizophrenia, and this makes the individuals vulnerable to seizure<sup>15,27</sup>.

Table (3): Localization and lateralization of ‘epileptiform’ activities

Localization	PWEIP (%)	PWS (%)	SUBTOTAL (%)
Bursts	27 (27.0)	8 (8.0)	35 (17.5)
Fronto-temporal Region	7 (7.0)	6 (6.0)	13 (6.5)
Frontal	6 (6.0)	0 (0.0)	6 (3.0)
Temporal	3 (3.0)	1 (1.0)	4 (2.0)
Focal+ Burst Activities	4 (4.0)	2 (2.0)	6 (3.0)
Total	47 (47.0)	17 (17.0)	64 (32.0)
Lateralization	PWEIP+ PWS (%)		
Right Hemisphere	6 (3.0)		
Left Hemisphere	5 (2.5)		
Bilateral Hemispheres	53 (26.5)		
Total	64 (32.0)		

Local:  $X^2=20.7$  (with Fisher’s correction),  $df=1$ ,  $p=0.00^{**}$ . Lateral:  $X^2=21.4$ ,  $df=4$ ,  $p=0.00^{**}$ .

In term of localization, ‘burst’ epileptiform activities constitute the highest in both groups. This is followed by localization in either Frontal, Temporal or Fronto-temporal regions, compared with other cortical areas.

In term of intra-group analysis, of those subjects with focal EEG epileptiform activities, relatively more percentage (41.2%) of PWS had fronto-temporal localization compared to 34.0% of the PWEIP group. Many studies in the past support this finding of predominant localization of focal epileptiform activities in the ‘Fronto-temporal’ regions of the brain of subjects with psychotic disorders<sup>28,29,30</sup>. An important explanation for this finding include the fact that cerebral insults in early childhood have been linked to cortical maldevelopment, limbic dysfunction and increased electrophysiological abnormalities. Furthermore, the abnormal cortical development has been reported to involve the corpus callosum, left neocortex, hippocampus and amygdala; and these deep

limbic structures are overlaid by the fronto-temporal region of the brain; thus the increased prevalence of EEG abnormalities over these fronto-temporal areas compared with other regions of the brain<sup>30, 31,32</sup>.

#### CONCLUSION:

In our study, there are a number of limitations such as the small samples and the use of surface electrode placement only in the EEG recording. However, despite these limitations, it can be concluded that a number of subjects in our sample with inter-ictal psychosis and PWS have EEG epileptiform activities reflecting cerebral insults in early life. Thus, preventive measures such as good antenatal care and child health care services are advocated to minimize the occurrence of these neuro-psychiatric disorders.

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