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SEIZURE CONTROL STATUS AND ITS PREDICTORS AMONG CHILDREN WITH EPILEPSY IN SOKOTO

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ABSTRACT

Epilepsy comprises a diverse group of neurological disorders affecting approximately 10.5 million children globally and 671,000 in Nigeria. Appropriately selected antiseizure medication (ASM) remains the first-line treatment for its management. This study, therefore, assessed the predictors of good seizure control status among children with epilepsy receiving care at tertiary health facilities in a Northwestern Nigerian state. This study presents a seven-year retrospective review of epilepsy management among patients under 15 years of age who received care at the Paediatric Neurology Clinics of Usmanu Danfodiyo University Teaching Hospital, Sokoto and Federal Neuropsychiatric Hospital, Kware, Sokoto. A total of 2,250 children with epilepsy (CWE) were included in the study. The median (IQR; range) age, age at seizure onset, and epilepsy duration were 9 (5–12; 0.33–14) years, 2 (1–5; 0.003–13) years, and 5 (2.42–6.58; 0–14) years, respectively. Most participants were males (65.3%), in school (50.7%), without comorbidities (76.9%), triggers (94.2%), or ASM adverse effects (88.0%). ASM monotherapy (91.1%) and adherence (71.1%) were common. Good seizure control occurred in 51.1% of CWE and was predicted by low socioeconomic status (P=0.000, OR=2.166, 95% CI=1.683–2.788), absence of comorbidity (P=0.000, OR=2.428, 95% CI=1.819–3.242), no epilepsy-induced injury (P=0.000, OR=3.324, 95% CI=1.849–5.976), history of status epilepticus (P=0.000, OR=2.345, 95% CI=1.805–3.047), herbal remedy use (P=0.000, OR=3.735, 95% CI=2.841–4.909), and carbamazepine monotherapy (P=0.000, OR=3.816, 95% CI=2.822–5.161). Good seizure control in the study cohort was predicted by carbamazepine monotherapy, low socioeconomic status, history of status epilepticus or herbal remedy use, and absence of comorbidity or epilepsy-induced injury.

Keywords: Adherence, Carbamazepine, Ictus, Strata, Therapies

INTRODUCTION

Epilepsy is a heterogeneous group of neurological disorders afflicting 10.5 million children younger than 15 years globally and 671000 nationally [Igwe and Aronu, 2021; Watila *et al*., 2021]; representing 20 % and 37 % of global and national epilepsy population respectively [Feigin *et al*., 2025]. This disorder is marked by chronic unprovoked, recurrent seizures or episodes of abnormal behaviour, which may lead to fatal outcomes if inadequately controlled [Gogou and Cross, 2022; Sumadewi *et al*., 2023]. This

encephalopathy shows an increasing global prevalence with variations in diagnostic criteria, treatment approaches and patient-specific prognoses [Feigin *et al*., 2025; Biset *et al*., 2024; Junges *et al*., 2024]. Therefore, individualised therapy aimed at achieving optimal seizure control, minimizing treatment-related side effects and enabling children with epilepsy to function comparably to their peers in the general population should remain a primary therapeutic goal. Because optimal pharmacotherapy with antiseizure medication (ASM) is considered the cornerstone in the management of CWE [Itamura *et al*., 2023; Janmohamed *et al*., 2023]; this consideration often involves careful antiseizure medication selection based on seizure/epilepsy type, patient characteristics (eg; comorbidities, socioeconomic status), antiseizure medication [Moosa 2019; Deng and Husari, 2024]. Resource-limited settings such as Nigeria account for over 80 % of the global epilepsy burden in terms of prevalence, mortality and disability adjusted life years, potentially hindering the nation's progress toward achieving the Sustainable Development Goals by 2030 [Feigin *et al*., 2025]. Furthermore, recurrent seizures can impair the brain health of affected children and impose significant socioecomic and psychological burdens on their families and communities [Biset *et al*., 2024; Junges *et al*., 2024]. Notably, the factors influencing seizure control among children with epilepsy have not been well characterised in Northern Nigeria; hence this study assessed the predictors of effective seizure control in children with epilepsy receiving care in tertiary health facilities in Northwestern Nigerian state.

METHODS

Study Design and Setting

This seven-year descriptive, cross-sectional, hospital-based retrospective chart review examined epilepsy care among children under 15 years who attended the Paediatric Neurology Clinics of Usmanu Danfodiyo University Teaching Hospital, Sokoto (UDUTHS) and the Federal Neuropsychiatric Hospital, Kware (FNPHK), Sokoto. While the Federal Neuropsychiatric Hospital, Kware operates a daily paediatric neurology clinic, the Paediatric Neurology Clinics of Usmanu Danfodiyo University Teaching Hospital runs a weekly clinic. The study was conducted over six months, beginning in October, 2024.

Eligibility Criteria

The study included patients under 15 years diagnosed with epilepsy (with or without co-morbidities) who received care at the study centres between January 1, 2018 and October 31, 2024. Patients who sought care before this period or had missing case files or incomplete clinical data were excluded.

Sample Size Determination and Sampling Technique

Using the sample size determination formula described by Bolarinwa (2020), childhood epilepsy prevalence rate of 0.47 [Ahmad *et al*., 2018], level of precision of 0.05 and 20% contingency; a sample size of 460 was obtained. Similarly, using a ratio of 3:1 (due to the variations in patient volume between the study centres); 460 was for UDUTHS and 1380 for FNPHK. However, in order to improve the study power; 562 folders was eventually used for UDUTHS and 1,688 for FNPHK. Consequently, the total sample size for the study was 2,250.

The patient registers from both study centres initially identified 2,868 children with epilepsy (CWE). However, this number was reduced to 2,250 (78.5%) after excluding records with less than three months duration of anti-seizure medication (ASM) therapy, those lost to follow-up, and folders that were irretrievable or contained incomplete information. Consequently, all 2,250 eligible case files were included in the study.

Data Collection

A structured proforma (data collection sheet) was used to extract relevant information from the case files of eligible participants- children with epilepsy (CWE) who received care during

the study period and had complete records. The case files were arranged chronologically by the date of first hospital visit, from January 1, 2018, to October 31, 2024. Data collected included sociodemographic variables (age, gender, maternal marital status, socioeconomic status and school attendance) and medical history (epilepsy duration, epilepsy-related injuries, seizure and ASM type, ASM adherence status and adverse effects). The socioeconomic status (SES) of parents or caregivers was classified as low, middle, or high, following the classification by Ogunyinka *et al*. [2022].

Socioeconomic status (SES) was calculated by taking the average of the sum of the scores obtained from parents'/guardians' educational level and occupation. When the adult involved is single, the denominator is 2 and 4 for currently married. Those with an SES score of ≤ 1.00 were classified as low, 1.25 to 2.50 as middle and ≥ 2.75 as high.

Data analysis

The data was analyzed using IBM SPSS statistics software, version 26.0 (IBM Corporation, Armonk, NY, USA: released 2019). The predictor (independent) variables comprised sociodemographic (such as age, gender, place of birth and residence, etc) and clinical variables (such as age at first seizure, presence of comorbidities and precipitating factors, ASM treatment modalities and its associated adverse effects, etc) while the seizure control outcome (status) comprised the outcome (dependent) variables.

Collected data were presented as proportions and summarized as median and interquartile range following insignificant p-value associated with Shapiro-Wilk statistics. Predictor (independent) variables with p-value of ≤ 0.05 and Phi coefficient ≥ 0.15 from univariate analysis were then entered into a binary logistic model to determine the predictors of good seizure control status. All associations at $p \leq 0.05$ were considered statistically significant with effect sizes (using Phi coefficient) of 0.20 (small effect), 0.50 (medium effect) and 0.80 (large effect) used to determine its strength [Bolarinwa, 2020]. Controlled seizure referred to seizure freedom of at least one year duration [Adal *et al*., 2021].

The study was approved by the Health Research and Ethics Committees of Usmanu Danfodiyo University Teaching Hospital, Sokoto and the Federal Neuropsychiatric Hospital, Kware, Sokoto.

RESULTS

A total of 2,250 eligible children with epilepsy (CWE) participated in the study. The median (interquartile range; difference range) for participants' age, age at seizure onset and epilepsy duration are 9 (5-12; 0.33-14.00) years, 2 (1-5; 0.003-13) and 5 (2.42-6.58; 0-14) respectively. Additionally, majority of the study participants are males (1470; 65.3%), attending school (1140; 50.7%) and without comorbidities (1730; 76.9%) or triggers (2120; 94.2%) or ASM adverse effect (1980; 88.0%). However, most participants were receiving ASM monotherapy (2050; 91.1%) and ASM adherent (1600; 71.1%). Other relevant characteristics of the study participants are presented in Table 1.

Two hundred and seventy adverse effects were reported with carbamazepine monotherapy (160; 59.3%) and sodium valproate polytherapy (30; 11.1%) being associated with the highest number of adverse effects for either monotherapy or polytherapy treatment modalities. Sodium valproate monotherapy was not associated with any adverse effect.

Table 1 Characteristics of study participants (N=2,250)

Characteristics	Frequency (%)
Age (years)	
Below one year	140 (6.2)
1-4	380 (16.9)
5-11	1120 (49.8)
12-14	610 (27.1)
Age at seizure onset (years)	
Within one year	760 (33.8)
Within 4 years	860 (38.2)
5-13	630 (28.0)
Duration of epilepsy (years)	
Below one year	250 (11.1)
1-5	1000 (44.4)
Above 5-10	880 (39.1)
Above 10-14	120 (5.3)
Place of birth (N=1110)	
Home	320 (28.8)
Private hospital	50 (4.5)
General hospital	500 (45.0)
Teaching hospital	240 (21.6)
Maternal marital status	
Married	2140 (95.1)
Divorced	10 (0.4)
Separated	50 (2.2)
Widowed	50 (2.2)
Socioeconomic status	
Low	1120 (49.8)
Middle	800 (35.6)
High	330 (14.7)
Family history of epilepsy (N=230)	
First degree relatives	110 (47.8)
Second degree relatives	110 (47.8)
First and second degree relatives	10 (4.3)
Seizure type	
Focal onset	110 (4.9)
Generalised onset	2120 (94.2)
Focal/Generalised onset	10 (0.4)
Unknown onset	10 (0.4)
Modification of antiseizure medication therapy	
None	1460 (64.9)
Dose decrease	50 (2.2)
Dose increase	590 (26.2)
change of antiseizure medication	150 (6.7)
Seizure control status	
Controlled	1150 (51.1)
Uncontrolled	1100 (48.9)

The types of adverse effects associated with their suspected antiseizure medication modalities are drowsiness/somnolence/weakness: carbamazepine monotherapy-40, phenobarbitone monotherapy-10; body rash: carbamazepine polytherapy-20, carbamazepine monotherapy-10, phenobarbitone monotherapy-20; sodium valproate polytherapy-10; headache: carbamazepine monotherapy-30; insomnia: carbamazepine monotherapy-10; abdominal pain/poor appetite: carbamazepine-20; respiratory depression: phenobarbitone monotherapy-10, phenobarbitone polytherapy-10; restlessness: carbamazepine monotherapy-40; phenobarbitone monotherapy-10, sodium valproate polytherapy-20 and leg tingling sensation: carbamazepine monotherapy-10.

Table 2 depicted significant associations between different characteristics of study participants and their seizure control status including their respective effect sizes. Others are age (P =0.000; Phi coefficient=0.414), age at seizure onset (P =0.000; Phi coefficient=0.449), epilepsy duration (P =0.000; Phi coefficient=0.368), mother's marital status (P =0.000; Phi coefficient=0.119), school attendance (P =0.000; Phi coefficient=0.244), triggers (P =0.000; Phi coefficient=0.052) and family history of epilepsy (P =0.000; Phi coefficient=0.095).

Table 2 Comparison of participants' characteristics with their seizure control status

Characteristics	Seizure control status		Total	P value / Phi coefficient
	Controlled (%)	Uncontrolled (%)		
Socioeconomic status				0.000 / 0.406
Low	800 (35.6)	320 (14.2)	1120 (49.8)	
Middle	260 (11.6)	540 (24.0)	800 (35.6)	
High	90 (4.0)	240 (10.7)	330 (14.7)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	
Status epilepticus(N=2240)				0.000 / 0.399
No	550 (24.6)	940 (42.0)	1490(66.5)	
Yes	590 (26.3)	160 (7.1)	750 (33.5)	
Total	1140 (50.9)	1100 (49.1)	2240 (100)	
Comorbidity				0.000 / 0.286
No	1020 (45.3)	710 (31.6)	1730 (76.9)	
Yes	130 (5.8)	390 (17.3)	520 (23.1)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	
Electroencephalogram				0.000 / 0.301
No	870 (38.7)	510 (22.7)	1380 (61.3)	
Yes	280 (12.4)	590 (26.2)	870 (38.7)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	
Epilepsy-associated injury				0.000 / 0.149
No	1130 (50.2)	1010 (44.9)	2140 (95.1)	
Yes	20 (0.9)	90 (4.0)	110 (4.9)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	
Seizure type				0.000 / 0.180
Focal onset	20 (0.9)	90 (4.0)	110 (4.9)	
Generalized onset	1130 (50.2)	990 (44.0)	2120 (94.2)	
Focal/Generalized onset	0 (0)	10 (0.4)	10 (0.4)	
Unknown onset	0 (0)	10 (0.4)	10 (0.4)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	
Modification of antiseizure				

medication therapy				0.000 / 0.359
No	930 (41.3)	510 (22.7)	1440 (64.0)	
Yes	220 (9.8)	590 (26.2)	810 (36.0)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	
Antiseizure medication adverse effect				0.000 / 0.104
No	1050 (46.7)	930 (41.3)	1980 (88.0)	
Yes	100 (4.4)	170 (7.6)	270 (12.0)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	
Antiseizure medication adherence				0.000 / 0.220
No	220 (9.8)	430 (19.1)	650 (28.9)	
Yes	930 (41.3)	670 (29.8)	1600 (71.1)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	
Herbal remedy use				0.000 / 0.532
No	190 (8.4)	760 (33.8)	950 (42.2)	
Yes	960 (42.7)	340 (15.1)	1300 (57.8)	
Total	1150 (51.1)	1100 (48.9)	2250 (100)	

Figure 1 illustrated the seizure control outcome associated with each ASM treatment modality among the study participants. Carbamazepine monotherapy was associated with the highest number of controlled seizures (1000; 44.9%) while the use of phenobarbitone polytherapy did not resulted in any controlled seizure

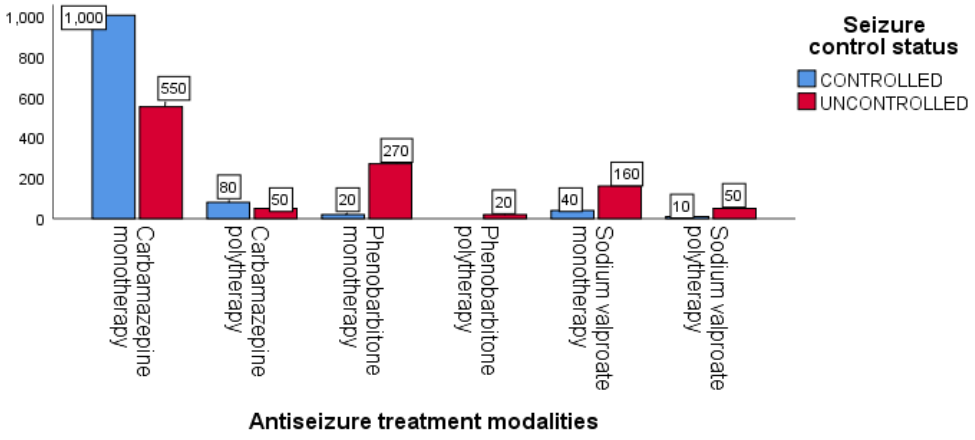

Figure 1 Participants' seizure control status according to their antiseizure treatment modalities

Carbamazepine polytherapy: carbamazepine and phenobarbitone-60; carbamazepine and sodium valproate-60; carbamazepine and phenobarbitone and sodium valproate-10; Phenobarbitone polytherapy: phenobarbitone and levetiracetam-10; phenobarbitone and topiramate-10; Sodium valproate polytherapy: sodium valproate and clonazepam-20; sodium valproate and phenobarbitone-30; sodium valproate and levetiracetam-10

Predictors of effective seizure control were shown in Table 3 with antiseizure medication treatment modalities being the strongest predictor.

Table 3 Predictors of Seizure Control

Predictors	P value	Odds ratio	95% confidence
Socioeconomic status	0.000	2.166	interval
Comorbidity	0.000	2.428	1.683-2.788
Epilepsy-associated injury	0.000	3.324	1.819-3.242
Status epilepticus	0.000	2.345	1.849-5.976
History of herbal remedy use	0.000	3.735	1.805-3.047
Antiseizure medication treatment modality	0.000	3.818	2.841-4.909
			2.822-5.161

DISCUSSION

The study findings suggest that epilepsy is a significant national health and development concern, its prevalence, disregard for ethnicity, religion and socioeconomic status (SES) and its effects on children with epilepsy (CWE), their families and the Nigerian society as a whole. Effective seizure control experienced by more than half (51.1 %) of the study participants was predicted by low socioeconomic status, no history of comorbidity or epilepsy-induced injury, history of status epilepticus or herbal remedy use and use of carbamazepine monotherapy.

Our finding that 51.1 % of study participants achieved seizure control is consistent with the reports of Adal *et al*. (2021) and Geremew *et al*. (2024) conducted among Ethiopian children with epilepsy but contrasts with findings from other studies in Nigeria [Okike *et al*., 2022] and Ethiopia by [Nasir *et al*., 2023; Alene *et al*., 2024]. The disparity between our findings and those of other studies may be attributed to the differences in sample size, study design, definitions of seizure control, and proportion of participants with drug-resistant epilepsy.

Carbamazepine monotherapy predicted controlled seizure among our study cohort. Carbamazepine appears to be more prescribed for CWE in Northern Nigeria [Ejeliogu *et al*., 2020; Omefe *et al*., 2022] while sodium valproate and phenobarbitone have reportedly been better favoured by clinicians in some centres in Southern Nigeria [Sykes, 2002; Okike *et al*., 2022] and Ethiopia [Geremew *et al*., 2024] respectively. This is not surprising as carbamazepine is a first-line anti-seizure medication indicated for the treatment of focal onset epilepsy and generalized tonic-clonic epilepsy (which 99.1% of the participants are diagnosed with) and for mood stabilizing effect (could be beneficial for 19.2% of the participants) [Rosati *et al*., 2015; Nevitt *et al*., 2022; World Health Organization, 2024]. Additionally, it is readily available, relatively affordable and has a favourable adverse effect profile [Beydoun *et al*., 2020; World Health Organization, 2024].

Poorly controlled epileptic seizures can lead to injuries occurring during seizure episodes [Milligan, 2021; Asiri *et al*., 2022]. Little wonder that study participants without history of epilepsy-induced injuries experienced controlled seizure. Like in our study, Alene and collaborators (2024) reported that lack of epilepsy-induced injury predicted controlled seizure among their study participants [Alene *et al*., 2024]. The similarity in findings between the two studies maybe attributed to comparable

seizure-related characteristics, particularly the proportion of participants who experienced their first seizure at ≤ 4 years (72.0%-our study *vs* 64.5%), status epilepticus (33.5% *vs* 37.0) and generalised and focal onset seizures (99.1% *vs* 84.5%). Other relevant profiles of study participants that could account for the observed similarity in study findings include similarities in the proportion of family history of epilepsy (10.2% *vs* 17.5%), comorbidities (23.1% *vs* 30.0%) and ASM adherence (71.1% *vs* 72.5%). ASM adherence is an acknowledged predictor of seizure control status among CWE [Adal *et al*., 2021; Okike *et al*., 2022; Nasir *et al*., 2022].

Comorbidities complicate the management of epilepsy and affects seizure control among children with epilepsy [Åndell, 2021; Geremew *et al*., 2023]. This may be attributed to the increased pill burden associated with comorbid conditions,which can reduce medication adherence and increase the risk of anti-seizure medications related adverse effects [Fadare *et al*., 2018]. Therefore, the presence of comorbidities should be a key pharmacotherapeutic consideration in the management of children with epilepsy [Moosa, 2019; Deng and Husari, 2024]. Neurological comorbidities are particularly common among children with epilepsy, with intellectual and developmental delays shown to predict early remission in cases of new-onset seizures [Aaberg *et al*., 2016; Ayoub *et al*., 2023].

Even though low socioeconomic status is associated with poor seizure control among children with epilepsy [Jareonsettasin *et al*., 2025], the opposite was observed in our study cohort. This led to further analysis of the characteristics of children with low socioeconomic status. These participants were predominantly those without epilepsy-induced injury (50.9 %) or comorbidity (53.2 %), receiving carbamazepine monotherapy (58.7 %), or receiving sodium valproate monotherapy (45.0 %-which was not associated with any adverse effect among them). They mostly required no dose or anti-seizure medication modification (73.3 %, with only dose reductions when necessary), demonstrated good anti-seizure mediciation (ASM) adherence (53.8 %) and were the least represented among those who experienced adverse effects (14.8 %). The first three characteristics of the study participants mentioned above are predictors of effective seizure control status among the study participants and this might be one of the reasons low SES predicted effective seizure control among our study cohort.

Two other notable findings were that the use of herbal remedies and a history of status epilepticus predicted effective seizure control among participants. Our study supports previous studies indicating that use of herbal remedies- the most common form of complementary and alternative medicine [Farrukh *et al*., 2018]- is widespread common among children with epilepsy [Yeon and Nam, 2016; Zhu *et al*., 2023]. Reported reasons for the continued use of herbal remedies include their perceived affordability, effectiveness and safety [Yeon and Nam, 2016; Farrukh *et al*., 2018; Zhu *et al*., 2023].

Due to the limited number of well-designed and rigorously conducted randomized controlled trials (RCTs) on the use of herbal remedies in children with epilepsy, their antiseizure efficacy remains inconclusive. Proponents suggest that certain herbal preparations possess anticonvulsant properties [Rabiei, 2017; He *et al*., 2023], whereas others believe that they may exert proconvulsive effects, alter cytochrome P450 enzymes, interact with anti-seizure medications and increase the risk of adverse effects [Liu *et al*., 2017; Zhu *et al*., 2023]. Since costs and drug-resistance is also a reason for the use of herbal remedies [Su *et al*., 2024]. It may therefore be advisable to subject some of these herbal remedies to rigorous preclinical investigations and randomized controlled trials (RCTs), which could potentially lead to the identification of safe and effective alternative anti-seizure medications for children with epilepsy.

Lastly, although the reason why a history of status epilepticus predicted effective seizure control in our study remains unclear, it is noteworthy that these participants had significantly fewer comorbidities (9.3% *vs* 30.2%; P=0.000), better anti-seizure medication adherence (77.3% *vs* 67.8%; P=0.000), higher school attendance (68.0% *vs* 41.6%; P=0.000), and predominantly experienced generalized tonic clonic seizure responsive to carbamazepine monotherapy (82.7% *vs* 61.7%; P=0.000). Consequently, they achieved significantly better seizure control than those without a history of status epilepticus (78.7% *vs* 36.9%; P=0.000).

Limitations of study

The generalizability of the study findings may be limited by its retrospective design. Nonetheless, the robustness of the results is strengthened by the multi-centre approach and the large sample size, which increased the study's statistical power.

CONCLUSION

Effective seizure control in our study cohort was predicted by use of carbamazepine monotherapy, low socioeconomic status, history of status epilepticus or herbal remedy use and the absence of comorbidities or epilepsy-related injuries.

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