ORIGINAL ARTICLE

Oral health assessment of epilepsy patients from a tertiary hospital in Asia

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ABSTRACT

Introduction: Oral health problems are frequently overlooked in patients with epilepsy. We evaluate the oral health status of epilepsy patients from a tertiary teaching hospital.

Materials and Methods: We conducted a cross-sectional study of epilepsy patients from the neurology clinic, Hospital Canselor Tuanku Muhriz, Kuala Lumpur. The dental assessment included the decayed, missing and filled teeth (DMFT) criteria, as well as the plaque and periodontal status by dentists.

Results: A total of 151 patients were recruited. The median age of onset of epilepsy was 16 (IQR 7-30) years, with generalised seizures at 59.6% and focal seizures in 40.4% of patients. Fair or poor oral health was present in 59 (39.1%) and gingivitis was seen in 65 (43%). The median DMFT decayed (D), missing (M) and filled teeth (FT) was 3 (IQR 1-7). The median age of patients with fair or poor oral health was older (40 years, IQR 31-51) than the patients with excellent or good oral health (33 years, IQR 26-45), (p=0.014). Multivariate logistic regression analysis showed that carbamazepine (Odds Ratios, OR: 3.694; 95% Confidence Intervals, 95%CI: 1.314, 10.384) and hypertension (OR 6.484; 95%CI: 1.011, 41.594) are the risk factors for fair or poor oral health. Phenytoin use is 4.271 times more likely to develop gingivitis (OR 4.271; 95% CI: 1.252, 14.573).

Conclusion: Factors that contribute to fair or poor oral health include age, antiseizure medications like phenytoin and carbamazepine, and hypertension. Effective preventive strategies should be implemented to maintain oral health in epilepsy patients.

KEYWORDS:
Oral health, dental, plaque index, gingival index, epilepsy

INTRODUCTION

Epilepsy is a heterogenous neurological disorder characterised by recurrent unprovoked seizures, with about 50 million people worldwide suffering from this condition. The lifetime prevalence and incidence of epilepsy are particularly high in low to middle-income countries.[1] Malaysia is a middle-income country with a population of 34.3 million, which comprises multiethnic groups. Malaysia's lifetime epilepsy prevalence is 7.8 per 1000 persons.[2] The frequency of seizures has a significant impact on the quality of life for individuals with epilepsy in Malaysia.[3]

In Malaysia, statistics suggest that oral healthcare may not be a priority among the population. Utilisation of oral healthcare facilities is estimated at only 13.2% among healthy adults aged 18 years and above.[4] Click or tap here to enter text. Based on the National Oral Health Survey of Adults 2010, 88.9% of Malaysian adults had dental caries (treated and untreated) and 94% had periodontal conditions.[5] Patients with epilepsy tend to have significantly more deteriorating physical and psychological health than the general population including dental problems.

The World Dental Federation has defined oral health as the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex.[6] Oral health is one of the aspects that may affect the quality of life inadvertently. Epilepsy patients may experience oral health problems following trauma[7] from seizures or antiseizure medications. The orofacial consequences of epileptic seizures include dental trauma such as crown fractures, intrusion, avulsion,[8] dentoalveolar fractures, as well as maxilla facial injuries[9] and soft tissue lacerations. Antiseizure medications such as phenytoin, valproate, carbamazepine or phenobarbital also affect periodontal disease.

Studies have shown that epilepsy patients are more vulnerable to oral health diseases. Wang et al. state that carious and missing teeth and periodontal indexes are significantly worse in patients with epilepsy.10 There is an increased predilection to anterior dental injuries in patients with epilepsy as compared with the prevalence earlier reported for those without epilepsy in Nigeria.[8]

This article was accepted: 08 June 2024
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To date, there has not been any reported data on the oral health problems in epilepsy in Malaysia. To address the significant burden of oral health problems in this specific group, additional attention is needed. Improved understanding of factors related to oral health disease facilitates the development of effective interventions. Hence, we embark on this study to delineate the prevalence and associated factors of oral health issues in epilepsy patients.

MATERIALS AND METHODS

Study Site and Participants

This cross-sectional study was conducted in Hospital Canselor Tuanku Muhriz, National University of Malaysia from 10 March 2022 to 30 November 2023. It was approved by the local Ethics and Research Board and funded by the National University of Malaysia (FF-2022-127). The study population included epilepsy patients over 18 years old who were recruited through simple random sampling. The exclusion criteria were pregnancy, non-epileptic disorders, neurodegenerative disorders and seizures secondary to alcohol or drugs. These were considered as confounding factors that could contribute to poor dentition.

Clinical Assessment and Diagnosis of Epilepsy

The selected patients were based on the specific inclusion criteria. After obtaining informed consent, data were collected on their demographics (age, gender, education), comorbid history (including psychiatric disorders such as depression, bipolar disorder, schizophrenia) and comprehensive epilepsy history (age of onset, seizure classification [focal or generalised], seizure frequency [per month, per year], cause of epilepsy [structural, genetic, infection, immunological, unknown]) and current antiseizure medications (ASM).

Oral Health Assessment

A clinical dental examination was conducted in the dental clinic for the dental assessment. The patients were interviewed using the 'Oral Health and Dental Status Questionnaire'.[10] Questions addressed tooth brushing habits, number of visits to dental clinics, oral symptoms and diagnosis, number of caries, tooth extraction, history of dental injury, tooth loss and dental restoration or repair. The level of oral hygiene, including a plaque index and periodontal status, including gingivitis and pocket depth, were measured with a periodontal probe. To score the plaque and gingival index, individual tooth was given an index score. Once all the teeth had been scored individually, the mean number of the plaque and gingival index were calculated for each participant.

Plaque index

The plaque index was used to measure the level of oral hygiene.[11] The criteria were as follows: 0 = no plaque in the gingival area; 1 = a thin plaque film adhering to the free gingival margin and adjacent area of the tooth, only recognisable by running a probe across the surface; 2 = moderate accumulation of soft deposits within the gingival pocket, on the gingival margin, and/or on the adjacent tooth surface; and 3 = abundant soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface. Subjects with a mean index score between 0.0-0.9 were considered to have excellent and good oral hygiene while mean index between 1.0-3.0 are considered fair or poor oral hygiene.

Gingival index

Periodontal status was determined using the gingival index and the criteria were as follows[11]: 0 = normal gingiva; 1 = mild inflammation: a slight change in colour, slight oedema and no bleeding on probing; 2 = moderate inflammation: redness, oedema and glazing, and bleeding on probing; and 3 = severe inflammation: marked redness and oedema, ulceration, and a tendency to spontaneous bleeding. Subjects with scores between 1.1 and 3.0 were considered to have gingivitis. Periodontal health was measured by registering the deepest pocket on the most posterior tooth in each quadrant, and a central incisor in each jaw, or the tooth closest to it if the index tooth was missing. Subjects with a measured pocket depth of 4 mm or more on one or more of the index teeth were considered to have periodontitis.

Decayed (D), missing (M) and filled teeth (FT) (DMFT)

The numbers of carious teeth were based on the detection of untreated decayed teeth. The World Health Organisation (WHO) caries diagnostic criterion for decayed (D), missing (M) and filled teeth (FT) (DMFT) was calculated.[12] The decayed, missing, filled teeth index is well established as the key measure for caries in dental services.

Statistical Analysis

All the data was analysed using SPSS software version 21.0. Continuous variables were expressed as median (interquartile range, IQR) and categorical variables as counts and frequencies (%). The Chi-square test was used for comparing categorical variables. The dependent variable was the plaque index and gingival index. The independent variables were demographic factors (age, gender, education, comorbidity), and clinical factors (age of onset of epilepsy, seizure types, frequency of seizures, type of ASM). The types of antiseizure medications that were included in the analysis were valproate, levetiracetam, lamotrigine, phenytoin, topiramate, perampanel, carbamazepine, clonazepam, clobazam, phenobarbitone and zonisamide. The distribution of continuous variables was compared using Student's t-tests; Pearson's Chi-square tests or Fisher's exact tests were used for the allocation of categorical variables. Multivariate logistic regression was performed to determine the risk factors. A p-value <0.05 defined statistical significance.

RESULTS

Demographic and Clinical Characteristics of Study Population

Table I shows the demographic and clinical characteristics of the study population. There were 151 patients, with 83 males (55%) and 68 females (45%). The median age was 37 (IQR 28-49) years. The distribution of race was predominantly Malay (76, 50.3%), Chinese (60, 39.7%), Indian (14, 9.3%) and others (1, 0.7%). The median age of onset of epilepsy was 16 (IQR 7 to 30) years, the proportion of patients with generalised seizures was 90 (59.6%) while 40.4% of patients had focal seizures. The median frequency of seizures per year

was 1 (IQR 0-12). The proportion of patients with ASM, mean dose and number of each ASM are depicted in Table I. The patients were divided into two groups with body mass index equal to or <22.9kg/m^2 (57, 37.7%) and ≥23kg/m^2 (94, 62.3%). The distribution of patients according to the plaque index: excellent or good oral health, 0.0-0.9 (92, 60.9%) and fair or poor oral health, 1.0-3.0 (59, 39.1%). The subdivision of plaque index was as follows: 0 (8, 5.3%), 0.1-0.9 (84, 55.6%), 1.0-1.9 (49, 32.5%) and 2.0-3.0 (10, 6.6%). The distribution of patients according to gingival index: normal, 0.0-1.0 (86, 57%) and gingivitis (65, 43%). The subdivision of gingival index was as follows: 0 (11, 7.3%), 0.1-1.0 (75, 49.7%), 1.1-2.0 (63, 41.7%) and 2.1-3.0 (2, 1.3%). The median DMFT was 3 (IQR 6).

Oral Health Assessment

Table 2 shows the oral health and dental status of the study population. 140 (92.7%) of the patients reported of brushing their teeth regularly with 76 (50.3%) brushing more than 3 minutes. However, around 55 (36.4%) visited the dentist more than once per year. The following dental symptoms were reported by the patients: toothache (25,16.6%), gum bleeding (43, 28,5%), swollen gums (18, 11.9%), bad breath (38, 25.2%) and others (2, 1.3%). The proportion of patients who had dental injuries due to seizures was 17 (11.3%). Around 10% of the patients had teeth repair after dental injury. The proportion of dental disorders include pulp and periapical disease (23, 15.2%), gingivitis (19, 12.6%), periodontitis (4, 2.6%), and others (2, 1.3%).

Table III shows the plaque index and gingival index of the study population. The median age of patients with fair or poor oral health was older (40 years, IQR 31-51) than the patients with excellent or good oral health (33 years, IQR 26-45), (p=0.014). However, age was not significantly associated with the gingival index (p=0.223). Gender and race have no significant association with the plaque and gingival indexes. The type and cause of epilepsy were not significantly associated with both plaque and gingival indexes. Among the different antiseizure medications, both carbamazepine and phenytoin were significantly associated with plaque index. The proportion of patients taking carbamazepine with poor oral health in plaque index was higher (26, 44.10%) vs good oral health (23, 25.00%), p=0.015. The proportion of patients on phenytoin with fair or poor oral health in plaque index was higher (14, 23.70%) vs good oral health (10, 10.90%). The proportion of patients on phenytoin with fair or poor oral health in the gingival index was higher (15, 23.10%) vs good oral health (9, 10.50%), p=0.036.

The risk factors for a high plaque index were presented in Table IV. Carbamazepine and hypertension were risk factors for fair or poor plaque index. Carbamazepine is 3.694 times more likely to develop a higher plaque index (adjusted Odds Ratios, aOR 3.694; 95% Confidence Intervals, CI: 1.314, 10.384). Hypertension is 6.484 times more likely to develop a higher plaque index (aOR 6.484; 95%CI: 1.011, 41.594). The risk factors for higher gingival index are shown in Table V. Phenytoin use was 4.271 times more likely to develop a higher gingival index (aOR 4.271; 95%CI: 1.252, 14.573).

DISCUSSION

Oral health plays a significant part in the quality of life of epilepsy patients. However, this aspect is often neglected in the management of these patients. This cross-sectional study highlighted that 39.1% of epilepsy patients had fair or poor oral health, and 43% had gingivitis. Oral health in people with epilepsy has been studied in rural China and the findings suggest that people with epilepsy have poor oral health and are vulnerable to dental injury.[10] An epidemiologic study from Hungary showed that all aspects of oral health and dental status of patients with epilepsy have a significantly worse state than that of the general population of the same group.[13] A prevalence study of oral health disorders in patients with epilepsy in Nigeria reported 69.6% with chronic periodontitis.[8] In a refractory epilepsy patient cohort in Brazil, this group showed significantly more susceptibility to develop poor oral hygiene (84.4%), gingivitis (56.9%) and periodontitis (47.4%) compared to controls.[14] Case reports have also highlighted that patients with concurrent epilepsy and intellectual impairment suffer from the consequences of poor oral hygiene and decayed teeth.[15]

This study has found that age is significantly associated with poorer oral health outcomes in epilepsy patients. Older epilepsy patients (median age 40, IQR 31-51) had poorer oral health compared to younger epilepsy patients (median age 33.5, IQR 26-45). There is currently limited information available on the relationship between age and oral health in epilepsy patients in the existing literature. Older individuals commonly experience dental caries, periodontal disease, oral cancer, and edentulousness. It has been estimated that 30% of adults aged 65-74 years are edentulous, which is attributed to periodontal disease.[16] The World Health Organisation reported that dental caries and periodontal disease were considerable health problems in older people in the majority of countries.[17] Poor oral health can lead to various negative effects such as reduced chewing performance, weight loss, impaired communication, and overall well-being. As individuals grow older, they experience physiologic changes that can lead to poor dental health. This includes a decrease in salivary gland function, a weakening of the protective barrier of the oral mucosa, alterations in teeth due to ageing, and a reduction in the blood supply to the sub-odontogenic region.[18]

The oral health of epilepsy patients is likely to be affected by several reasons. They are prone to be edentulous earlier[13] following jaw and dental injuries from generalised tonic-clonic seizures[19] and the effects of antiseizure medications.[21] Although this study did not show any significance between the median frequency of seizures and oral health, previous studies have established that refractory epilepsy patients are at higher risk of dental trauma, and seizure frequency is linked to higher rates of dental injuries. Patients with poorly controlled epilepsy and frequent generalised tonic-clonic seizures have worse oral health compared to those with better control.[13]

Antiseizure medications have also been implicated as part of the cause for aggravation of poor oral health. Carbamazepine acts on stabilisation of the inactivated state of voltage-gated sodium channels[21] and is indicated for focal

Table I: Demographics and characteristics of the study population.

N=151		Values	Percentage (%)
Median age (IQR) (years)		37 (28-49)	
Gender			
Female		68	45
Male		83	55
Race			
Malay		76	50.3
Chinese		60	39.7
Indian		14	9.3
Others		1	0.7
Education			
No formal education		20	13.2
Primary		11	7.3
Secondary		58	38.4
Tertiary		62	41.1
Epilepsy			
Median age of onset of epilepsy (IQR) (years)		16 (7-30)	
Type of epilepsy	Focal	61	40.4
	Generalised	90	59.6
Cause of epilepsy	Structural	106	70.2
	Genetic	32	21.2
	Infection	6	4
	Immunology	3	2
	Unknown	4	2.6
Median frequency of seizure (IQR) (per year)		1 (0-12)	
Anti-seizure drugs			
Median number of anti-seizure drugs (IQR)		1 (1-2)	
Carbamazepine	No	102	67.5
	Yes	49	32.5
Clonazepam	No	142	94
	Yes	9	6
Clobazam	No	146	96.7
	Yes	5	3.3
Diamox	No	149	98.7
	Yes	2	1.3
Levetiracetam	No	76	50.3
	Yes	75	49.7
Lamotrigine	No	128	84.8
	Yes	23	15.2
Perampanel	No	148	98
	Yes	3	2
Phenytoin	No	127	84.1
	Yes	24	15.9
Phenobarbitone	No	147	97.4
	Yes	4	2.6
Topiramate	No	135	89.4
	Yes	16	10.6
Sodium Valproate	No	91	60.3
	Yes	60	39.7
Zonisamide	No	148	98
	Yes	3	2
Comorbidity			
Diabetes	No	141	93.4
	Yes	10	6.6
Hypertension	No	134	88.7
	Yes	17	11.3
Ischemic heart disease	No	149	98.7
	Yes	2	1.3
Asthma	No	148	98
	Yes	3	2
Chronic kidney disease	No	150	99.3
	Yes	1	0.7
Previous stroke	No	143	94.7
	Yes	8	5.3
Brain tumour	No	146	96.7
	Yes	5	3.3
Psychiatric disease	No	142	94
	Yes	9	6

Table I: Demographics and characteristics of the study population.

N=151		Values	Percentage (%)
Median BMI (IQR) (kg/m2)		24.17 (21.30-27.38)	
Body mass index <23.0	Normal	57	37.7
Body mass index ≥23.0	Overweight and above	94	62.3
Plaque Index	0	8	5.3
0.1-0.9	84	55.6	
1.0-1.9	49	32.5	
2.0-3.0	10	6.6	
Gingival Index	0	11	7.3
0.1-1.0	75	49.7	
1.1-2.0	63	41.7	
2.1-3.0	2	1.3	
Plaque Index	Excellent/good oral health (0-0.9)	92	60.9
	Fair/poor oral health (1.0-3.0)	59	39.1
Gingival Index	Normal (0.0-1.0)	86	57
	Gingivitis (1.1-3.0)	65	43
Median DMFTs (IQR)		3 (1-7)	

IQR Interquartile range, BMI Body mass index; DMFT decayed (D), missing (M) and filled teeth (FT)

Table II: Oral health and dental status of the study population.

Questionnaire		N=151	%
1. Do you brush your teeth regularly			
	Yes	140	92.7
Median brush per day (IQR)		2 (1-2)	
Median brush duration (IQR)		3 (1-5)	
Brushing time cutoff 3 min	<3 min	75	49.7
	≥3 min	76	50.3
2. Median dental visit per year (IQR)		0 (0-1)	
	No dental visit	96	63.6
	More than 1 dental visit/year	55	36.4
3. Do you have the following symptoms?			
Toothache	Yes	25	16.6
Gum bleeding	Yes	43	28.5
Swollen gums	Yes	18	11.9
Bad breath	Yes	38	25.2
Others	Yes	2	1.3
4. Do you have any caries	No	76	50.3
	Yes	75	49.7
Median number of caries (IQR)		2 (1-3)	
5. Do you have any tooth extracted due to caries?	No	96	63.6
	Yes	55	36.4
Median number of extraction due to caries (IQR)		2 (1-3)	
6. Do you have any dental injuries due to seizures	No	134	88.7
	Yes	17	11.3
Median number of dental injuries due to seizures (IQR)		1 (1-2)	
Median number of fracture due to seizure injuries (IQR)		1 (1-2)	
7. Do you have any dental injuries due to other reasons?	No	143	94.7
	Yes	8	5.3
Median number of dental injuries due to other reasons (IQR)		1.5 (1-2)	
Median number of fracture due to other injuries (IQR)		1 (1-2)	
8. Apart from the change of teeh as a child, have you every had natural tooth loss?	Yes	30	19.9
Median number of natural loss (IQR)		2 (1-4)	
9. Have you had your tooth repaired after dental injury or tooth loss?	Yes	16	10.6
What type of tooth repair?	Dental Crown	1	0.7
	Dental prosthesis	7	4.6
	Others	8	5.3
	Total	16	10.6
10. Have you ever been diagnosed by your dentists for:			
Dental diagnosis: Pulpal and periapical disease	Yes	23	15.2
Dental diagnosis: Gingivitis	Yes	19	12.6
Dental diagnosis: Periodontitis	Yes	4	2.6
Dental diagnosis: Others	Yes	2	1.3

Table III: Plaque index and gingival index of study population.

Variable	Plaque Index Categorical		p-value	Gingival Index		p-value
	Excellent/good oral health	Fair/poor oral health		Normal	Gingivitis	
Median age (IQR) (years)	33.5 (26-45)	40 (31-51)	0.014[U]	35.5 (26.75-45.25)	38 (29.5-51.0)	0.223[U]
Gender	n=92	n=59		n=86	n=65	
Gender						
Male	45 (48.90%)	23(39.00%)	0.231[c]	43(50.00%)	25(38.50%)	0.158 [c]
Female	47(51.10%)	36 (61.00%)		43 (50.00%)	40 (61.50%)	
Race	n=92	n=59		n=86	n=65	
Race						
Malay	47 (51.10%)	29 (49.20%)	0.824[c]	41 (47.70%)	35 (53.80%)	0.284 [c]
Chinese	35 (38.00%)	25 (42.40%)		33 (38.40%)	27 (41.50%)	
Indian	9 (9.80%)	5 (8.50%)		11 (12.80%)	3 (4.60%)	
Others	1 (1.10%)	0 (0%)		1 (1.20%)	0 (0%)	
Education	n=92	n=59		n=86	n=65	
Education level						
None	9 (9.80%)	11 (18.60%)	0.006[c]	10 (11.60%)	10 (15.40%)	0.658 [c]
Primary	6 (6.50%)	5(8.50%)		6 (7.00%)	5 (7.70%)	
Secondary School	29 (31.50%)	29 (49.20%)		31 (36.00%)	27 (41.50%)	
Tertiary Education	48 (52.20%)	14 (23.70%)		39 (45.30%)	23 (35.40%)	
Epilepsy	n=92	n=59		n=86	n=65	
Type of Epilepsy						
Focal	37 (40.20%)	24 (40.70%)	0.955[c]	31 (36.00%)	30 (46.20%)	0.210 [c]
Generalised	55 (59.80%)	35(59.30%)		55 (64.00%)	35 (53.80%)	
Cause of Epilepsy						
Structural	65 (70.70%)	41(69.50%)	0.067[c]	63 (73.30%)	43 (66.20%)	0.218 [c]
Genetic	17 (18.50%)	15(25.40%)		15 (17.40%)	17 (26.20%)	
Infection	6 (6.50%)	0 (0.00%)		4 (4.70%)	2 (3.10%)	
Immunology	3 (3.30%)	0 (0.00%)		3(3.50%)	0 (0.00%)	
Unknown	1 (1.10%)	3 (5.10%)		1 (1.20%)	3 (4.60%)	
Anti seizure medications	n=92	n=59		n=86	n=65	
Carbamazepine						
No	69 (75.00%)	33 (55.90%)	0.015[c]	62(72.10%)	40 (61.50%)	0.170 [c]
Yes	23 (25.00%)	26 (44.10%)		24 (27.90%)	25 (38.50%)	
Clonazepam						
No	86 (93.50%)	56 (94.90%)	1.000*	79 (91.90%)	63 (96.90%)	0.301*
Yes	6 (6.50%)	3 (5.10%)		7 (8.10%)	2 (3.10%)	
Clobazam						
No	88 (95.70%)	58 (98.30%)	0.649*	83 (96.50%)	63 (96.90%)	1.000*
Yes	4 (4.30%)	1 (1.70%)		3 (3.50%)	2 (3.10%)	
Diamox						
No	91 (98.90%)	58 (98.30%)	1.000*	86 (100.00%)	63 (96.90%)	0.184*
Yes	1 (1.10%)	1 (1.70%)		0 (0.00%)	2 (3.10%)	
Levetiracetam						
No	41 (44.60%)	35 (59.30%)	0.077[c]	40 (46.50%)	36 (55.40%)	0.325[c]
Yes	51 (55.40%)	24 (40.70%)		46 (53.50%)	29 (44.60%)	
Lamotrigine						
No	76 (82.60%)	52 (88.10%)	0.356[c]	71 (82.60%)	57 (87.70%)	0.385[c]
Yes	1617.40%	711.90%		1517.40%	812.30%	
Perampanel						
No	90 (97.80%)	58 (98.30%)	1.000*	85 (98.80%)	63 (96.90%)	0.578*
Yes	2 (2.20%)	1 (1.70%)		1 (1.20%)	2 (3.10%)	
Phenytoin						
No	82 (89.10%	4576.30%	0.035 [c]	7789.50%	5076.90%	0.036[c]
Yes	10 (10.90%)	14 (23.70%)		9 (10.50%)	15 (23.10%)	
Phenobarbitone						
No	90 (97.80%)	57 (96.60%)	0.644*	84 (97.70%)	63 (96.90%)	1.000*
Yes	2 (2.20%)	2(3.40%)		2(2.30%)	2 (3.10%)	
Topiramate						
No	8592.40%	5084.70%	0.136[c]	76 (88.40%)	59 (90.80%)	0.636[c]
Yes	7 (7.60%)	9 (15.30%)		10 (11.60%)	6 (9.20%)	
Sodium valproate						
No	59 (64.10%)	32 (54.20%)	0.225[c]	54 (62.80%)	37 (56.90%)	0.466 [c]
Yes	33 (35.90%)	27 (45.80%)		32 (37.20%)	28 (43.10%)	
Zonisamide						
No	91 (98.90%)	57 (96.60%)	0.561*	85 (98.80%)	63 (96.90%)	0.578*
Yes	1 (1.10%)	2 (3.40%)		1 (1.20%)	2 (3.10%)	

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Table III: Plaque index and gingival index of study population.

Variable	Plaque Index Categorical		p-value	Gingival Index		p-value
	Excellent/good oral health	Fair/poor oral health		Normal	Gingivitis	
Diabetes						
No	86 (93.50%)	55 (93.20%)	1.000*	80 (93.00%)	61 (93.80%)	1.000*
Yes	6 (6.50%)	4 (6.80%)		6 (7.00%)	4 (6.20%)	
Hypertension						
No	84 (91.30%)	50 (84.70%)	0.213c	77 (89.50%)	57 (87.70%)	0.723 [c]
Yes	8 (8.70%)	9 (15.30%)		9 (10.50%)	8 (12.30%)	
Ischemic Heart Disease						
No	92 (100.00%)	57 (96.60%)	0.151*	85 (98.80%)	64 (98.50%)	1.000*
Yes	0 (0.00%)	2 (3.40%)		1(1.20%)	1 (1.50%)	
Asthma						
No	90 (97.80%)	58 (98.30%)	1.000*	85 (98.80%)	63 (96.90%)	0.578*
Yes	2 (2.20%)	1 (1.70%)		1 (1.20%)	2 (3.10%)	
Chronic Kidney Disease						
No	92 (100.00%)	58 (98.30%)	0.391*	85 (98.80%)	65 (100.00%)	1.000*
Yes	0 (0.00%)	1 (1.70%)		1 (1.20%)	0 (0.00%)	
Previous Stroke						
No	88 (95.70%)	55 (93.20%)	0.712*	81 (94.20%)	62 (95.40%)	1.000*
Yes	4 (4.30%)	4 (6.80%)		5 (5.80%)	3 (4.60%)	
Brain tumor						
No	88 (95.70%)	58 (98.30%)	0.649*	82 (95.30%)	64 (98.50%)	0.391*
Yes	4 (4.30%)	1 (1.70%)		4 (4.70%)	1 (1.50%)	
Psychiatric disorders						
No	85 (92.40%)	57 (96.60%)	0.483*	79 (91.90%)	63 (96.90%)	0.301*
Yes	7 (7.60%)	2 (3.40%)		7 (8.10%)	2 (3.10%)	
BMI (kg/m^2)						
N ≤ 22.9 kg/m^2	36 (39.10%)	21 (35.60%)	0.662c	31 (36.00%)	26 (40.00%)	0.620 [c]
Overweight and above ≥ 23 kg/m^2	56 (60.90%)	38 (64.40%)		55 (64.00%)	39 (60.00%)	
Median age of onset of epilepsy (IQR) (years)	18 (10 to 29)	12 (2 to 34)	0.075 [u]	18 (9 to 30)	13 (6 to 26)	0.173 [u]
Median frequency of seizure (IQR)	1 (0 to 12)	4 (0 to 24)	0.312 [u]	1 (0 to 12)	3 (0 to 24)	0.336 [u]
Median number of anti seizure medications (IQR)	1 (1 to 2)	1 (1 to 3)	0.373 [u]	1 (1 to 2)	1 (1 to 3)	0.903 [u]
Median BMI (IQR) (kg/m^2)	23.76 (21.24 to 27.35)	24.46 (21.35 to 27.70)	0.41 [u]	24.22 (21.55 to 27.48)	23.66 (20.79 to 26.82)	0.415 [u]
Median DMFTs (IQR)	3 (0 to 6)	4 (2 to 9)	0.018 [u]	3 (0.75 to 7)	3 (1.5 to 7)	0.417 [u]

IQR Interquartile range; BMI Body mass index; DMFT decayed (D), missing (M) and filled teeth (FT); Fishers exact test*; Pearson Chi square testc; Mann Whitney U test [u]

Table IV: Risk factors for plaque index.

	B	S.E.	Wald	df	Sig.	Odds Ratio	95% Confidence Intervals	
							Lower	Upper
Carbamazepine	1.307	0.527	6.14	1	0.013	3.694	1.314	10.384
Hypertension	1.869	0.948	3.886	1	0.049	6.484	1.011	41.594
Psychiatric disease	-1.824	1.018	3.209	1	0.073	0.161	0.022	1.187
Age	0.031	0.021	2.206	1	0.137	1.032	0.99	1.075
Phenytoin	0.889	0.624	2.032	1	0.154	2.434	0.716	8.268
Gender	0.614	0.472	1.693	1	0.193	1.848	0.733	4.659
Frequency of seizure	0.005	0.004	1.598	1	0.206	1.005	0.997	1.014
Cause of epilepsy	1.778	1.414	1.58	1	0.209	5.915	0.37	94.599
Age of epilepsy onset	-0.024	0.02	1.49	1	0.222	0.976	0.938	1.015

B: Coefficient β, SE: Standard error, CI: Confidence interval, Exp (B): Odds ratio

seizures and primary generalised tonic-clonic seizures.[22] However, there are reports of the effects of carbamazepine on alveolar bone loss[23] and gingival hyperplasia.[24] Our study reinforces the fact that carbamazepine is a risk factor for fair or poor oral health and has 3.69 times of developing a higher plaque index. Conversely, a study in children with epilepsy on antiseizure monotherapy found that carbamazepine has no effect on gingival hyperplasia.[25] However, the number of patients was small (n=30) with a short follow-up at 6 months in this study. Another study on children and adolescents treated with carbamazepine for an average of three years, reported no intra-oral side effects from the treatment.[26]

Among the antiseizure medications, phenytoin is a first-generation anti-convulsant drug that is effective in the treatment of generalized tonic-clonic seizures, focal seizures,

Table V: Risk factors for gingival index.

	B	S.E.	Wald	df	Sig.	Odds Ratio	95% Confidence Intervals	
							Lower	Upper
Phenytoin	1.452	0.626	5.375	1	0.020	4.2711	1.252	14.573
Gender	0.819	0.449	3.322	1	0.068	2.269	0.94	5.475
Race	-1.5	0.825	3.302	1	0.069	0.223	0.044	1.125
Psychiatric disease	-1.565	0.982	2.536	1	0.111	0.209	0.031	1.435
Cause of epilepsy	0.658	0.519	1.605	1	0.205	1.931	0.698	5.342
Hypertension	1.136	0.915	1.539	1	0.215	3.113	0.518	18.726
Body mass index	-0.534	0.459	1.353	1	0.245	0.586	0.238	1.442
Type of epilepsy	-0.486	0.452	1.157	1	0.282	0.615	0.254	1.491

B: Coefficient β, SE: Standard error, CI: Confidence interval, Exp (B): Odds ratio

and status epilepticus. It works by blockade of voltage-dependent membrane sodium channels.[27] The effect of phenytoin on gingival hyperplasia has been well-documented in the literature.[28,29] Likewise, this study emphasised phenytoin as a risk factor with a 4.27 higher odds of developing gingivitis. In comparison, most previous reports were limited by the small number of participants. In a systematic review of anticonvulsants such as carbamazepine, ethosuximide, phenytoin, primidone, phenobarbital, and sodium valproate on gingival hyperplasia, these studies showed a correlation between different types of anticonvulsants and gingival hyperplasia. Phenytoin demonstrated the highest incidence between 15.61% and 73%.[30] A previous study examined the periodontal health of adult patients with epilepsy who had been treated with phenytoin or carbamazepine for an average of 18 years and it was observed grade 1 gingival hyperplasia developed in 35% of patients taking phenytoin compared to only 10% of patients on carbamazepine.[23]

Gingival hyperplasia is characterised by an increased amount of non-collagenous extracellular matrix associated with gingival inflammation. Mechanisms of phenytoin-induced gingival overgrowth are derived from in vitro studies documenting that cells derived from phenytoin-induced gingival overgrowth produce a cell-free extracellular matrix with special properties that regulate cell functions such as cell attachment and spreading.[31] Phenytoin also potentiates interleukin (IL-lα and IL-lβ) induced prostaglandin E2 biosynthesis in human gingival fibroblasts.[32]

This study established that hypertension is a significant risk factor for the deterioration of oral health in epilepsy patients. These results were concordant with the data from a large observational cohort of French patients where hypertension was associated with a high level of dental plaque (OR: 1.90; 95%CI: 1.55, 2.33), dental calculus (OR: 1.18; 95%CI: 1.07, 1.29) and gingival inflammation (OR: 1.56; 95%CI: 1.35, 1.80).[33] An epidemiological study has shown an inverse association between the frequency of tooth brushing and hypertension.[34] Periodontitis has been linked to higher systolic blood pressure in a more recent study.[35] Plaque accumulation around teeth leads to gingivitis, and our findings indicated a significant association between plaque index and hypertension. The mechanism of periodontitis leading to hypertension stems from oxidative stress that might contribute to functional and anatomic vascular changes in the long term, leading to arterial stiffness, increased vascular resistance and volume overload.[36]

Limitations: It's important to note that this study was performed in a single centre, so the results may not accurately represent the entire epilepsy population in Malaysia. Additionally, the study did not account for other factors, such as income, occupation, or nutritional status, which may have played a role in the negative outcomes observed. To gain a better understanding of whether the exposure being studied is truly linked to adverse outcomes, a case-control study with a control group that is age and gender-matched would be helpful.

CONCLUSION

This study highlights the fact that patients with epilepsy are prone to poor oral health and gingivitis. Factors such as age, antiseizure medications like phenytoin and carbamazepine and hypertension contribute to these conditions in epilepsy patients. It is crucial to effectively manage epilepsy and its associated oral health problems to ensure good overall health. Customised management strategies should be implemented to improve oral health.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no competing interests.

FUNDING

This study was funded by the National University of Malaysia following approval from the local ethics and research board with the grant code: FF-2022-127.

ACKNOWLEDGEMENTS

The authors would like to thank the Dean of the Faculty of Medicine at the National University of Malaysia for his permission to publish this article.

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