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Revisiting an ancient legend: Influence of the lunar cycle on occurrence of first-ever unprovoked seizures.

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1. INTRODUCTION

Tales of the mystical connection between the moon and neuropsychiatric conditions have persevered through time and cultures including within the healthcare community.[1] Seizures have not been immune to theories of lunar influence with references dating back to biblical times,[2] with several more recent studies yielding inconsistent results.[3-5]

Epileptic seizures are known to follow temporal patterns, the most commonly studied being the circadian rhythm and sleep-wake cycle.[6-8] Studies of seizure prediction have shown that infradian cycles of three weeks or more are not uncommon and because of an incidental alignment with the phase of the moon may have perpetuated the notion that the lunar cycle has a physiological effect on inhibitory or excitatory mechanisms of seizure initiation.[7] We sought to further assess the association of the lunar cycle with seizure based on well documented first-ever seizures rather than established epilepsy which may be more prone to a recall bias. Furthermore, the occurrence of a first ever seizure in a previously healthy adult is a frightening experience. Investigations are often negative and patients are left grappling for an explanation, often pondering over the influence of a various potential contributors including the full moon.

We present the findings of a retrospective study investigating whether first unprovoked seizures follow the temporal pattern of the lunar cycle.

2. METHODS

We retrospectively reviewed first seizure presentations at two major Australian tertiary hospitals in Western Australia between 2000 and 2015 and Victoria between 2010 to 2018. We identified participants through referral to the adult first seizure clinic and included participants with a first unprovoked seizure who had a clearly documented seizure onset time. For both datasets, the time of seizure onset was obtained from paramedic or emergency department records. The Human Research Ethics Committees of the respective hospitals approved this project.

We used the "Time and Date" website to identify the moon phase corresponding to the time and date of each seizure in Melbourne or Perth and tabulated the occurrence of seizures during the traditional four quarters of the synodic month.[9, 10] We allotted seizures into the four quarters of the lunar cycle (new moon, first quarter, full moon and third quarter), named after the primary lunar phase they follow.

We used Poisson regression to determine whether the seizures have a preponderance to occur during a particular phase of the lunar cycle. The incidence rate ratio (IRR) was used as the metric to express the association between the seizure count and the lunar phase by

exponentiating Poisson regression coefficients.[11] The lunar quarter with the lowest seizure count was used as the reference block to calculate the IRR for other quarters. P values of <0.05 were considered significant. All data analyses were conducted with Stata (version 15) statistical software package (StataCorp LLC, Texas, USA). Further analyses were conducted on the subgroups "first seizure epilepsy (FS-E)" and "first seizure not epilepsy (FS-nE)". Classification into FS-E was made if they had epileptiform activity on their EEG or an epileptogenic lesion on neuroimaging with an estimated seizure recurrence risk of >60% in line with the ILAE criteria for epilepsy following the first unprovoked seizure.[12] Participants with neither epileptiform activity on their EEGs nor epileptogenic lesions on neuroimaging were categorized as FS-nE.

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

3. RESULTS

1710 participants met the eligibility criteria (1302 from Western Australia and 408 from Victoria) and their clinical characteristics are detailed in Table 1. Clinical characteristics were homogenous between the two cohorts. There was no significant difference in occurrence of the first-ever seizures among the four lunar phases in the whole group analysis with seizures equally distributed during each phase. The full moon quarter was the reference block, which had the lowest seizure count of 415 (24%) seizures. Figure 1 shows the distribution of the first unprovoked seizures over the four lunar quarters. In keeping with the total cohort, a

lunar cycle influence was also not seen in the FS-E (p=0.83) and FS-nE (p=0.80) subgroups l. Seizure frequency and IRR for all groups are shown in Table 2.

4. DISCUSSION

In this large, multicentre cohort of first unprovoked seizures, there was no relationship between the phase of the lunar cycle and the timing of first-ever seizure, including those who would be regarded as having new-onset epilepsy. We did not find a preponderance for the seizures to occur during a particular phase of the lunar cycle in both the whole group and subgroup analyses. In fact, the four phases of the lunar cycle had very similar seizure counts.

Our study is an attempt to assess lunar cycle patterns in relation to the first unprovoked seizure occurrence in the community. Strengths include multi-centre design, sampling spontaneous unprovoked seizures, and comprehensive assessments of participants at first seizure clinics by experienced epileptologists who made the diagnosis of the first unprovoked seizure. The retrospective design of the study is a limitation. Interestingly, our findings are not in line with a retrospective review of emergency department seizure admissions in Greece, which reported an increased seizure frequency during the full moon.[13] However, that study included patients with epilepsy, without analysing the impact of confounding variables such as alcohol on breakthrough seizures. The evidence for non-epileptic seizures (previously known as pseudoseizures) following lunar cycles appears more consistent, with two studies reporting that the full moon was only associated with an increase in non-epileptic seizures[3, 4] and another finding a statistically significant skew towards the first quarter of the lunar

phase.[14] It should be noted those studies were based on data from epilepsy monitoring units rather than spontaneous seizures in the community, hence introducing a considerable bias. Our study's exclusion of non-epileptic seizures and provoked seizures through rigorous clinical assessment may explain the different results.

Lunar phases have been linked with many healthcare and medical variables, such as cardiopulmonary resuscitation, fertility, acute coronary events, and neuropsychiatric presentations; however, most studies do not show any association.[3, 15-21] Scientific underpinnings of the belief in lunar cycle influence are predominantly based on the moon's influence on night time brightness, lunar gravitational tides, and the endogenous biological clock.[4, 22] The full moon markedly increases illuminance, which may precipitate sleep deprivation and indirectly increase the risk of epileptic seizures. However, it is doubtful if the lunar brightness has any impact at all in the current environment heavily illuminated with electrical lighting. Secondly, the gravitational tides of the full moon affect the human body, either via direct disturbance of the bodily fluids or indirect influence on the Earth's electromagnetic field. However, mathematical calculations have indicated those changes are too small to have any impact on the human physiology.[22] Finally, certain animal species demonstrate behavioural patterns that follow the lunar cycle. An example is the Palolo worms, near Samoa and the Fiji island, which reproduce during the last quarter of the moon despite isolation from other environmental influences (e.g. light and weather).[23] The authors hypothesised the lunar cycle to be an external cue ("zeitgeber") influencing the endogenous

cycle in the worm. Though human epilepsy follows an intrinsic circadian rhythm entrained by zeitgebers,[24] there is no scientific evidence for moonlight as an external cue.

Though our study has no direct clinical implications, it does highlight the lack of biological association between the lunar cycle and seizures. Clinicians can educate their patients with certainty that though there are several triggers for seizures, the lunar cycle is not one of them.

5. CONCLUSION

Strongly held beliefs of lunar influences have long held the medical community captive. Epilepsy, in particular, is a condition with debilitating unpredictability for patients and the fear of lunar influence may add unnecessary anxiety during a full moon. Our study helps to debunk the myth that the full moon, or any part of the lunar cycle, is a risk factor for seizure occurrence and patients with unexplained first-ever seizure can be reassured that a full moon was not responsible.

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FIGURE LEGENDS:

Figure 1. Seizure count by lunar phase – whole group analysis

Table 1. Cohort demographics

	WA (1302)	VIC (408)	Total (1710)
Female (%)	485 (37%)	163 (40%)	648 (38%)
Median age (range)	38 (14-91)	42 (16-97)	39(14-97)
EEG epileptiform activity (%)	219 (17%)	87 (21%)	306 (18%)
Neuroimaging epileptogenic lesion	386 (30%)	86 (22%)	472 (28%)
First seizure type*			
Tonic-clonic (%)	1219 (94%)	318 (78%)	1536(90%)
Focal (%)	83 (6%)	43 (11%)	126 (7%)
Unspecified (%)	0 (0%)	47 (12%)	47 (3)
Electroclinical syndrome			
FS-E (%)	534 (41%)	150 (37%)	684 (40%)
FS-nE (%)	768 (59%)	258 (63%)	1026 (60%)

Abbreviations: WA = Western Australia; VIC = Victoria; EEG = electroencephalogram; FS-E = first seizure epilepsy subgroup; FS-nE = first seizure not epilepsy subgroup

*Tonic-clonic seizures = generalised, focal or unknown onset; focal = other types of focal seizures without progression to a tonic-clonic seizure

Table 2. Seizure frequency and IRRs of lunar quarters

	New moon	First quarter	Full moon	Third quarter
Whole group (p=0.80)				
Seizure frequency	441	434	415	420
IRR	1.06	1.05	Reference	1.01
FS-E (p=0.83)				
Seizure frequency	171	181	166	166
IRR	1.03	1.09	1	Reference
FS-nE (p=0.80)				
Seizure frequency	270	253	249	254
IRRs	1.08	1.01	Reference	1.02

Abbreviations: IRR = incidence rate ratio; FS-E = first seizure epilepsy; FS-nE = first seizure not epilepsy; Reference = group with the lowest seizure frequency used as the reference groups for calculation of the IRR

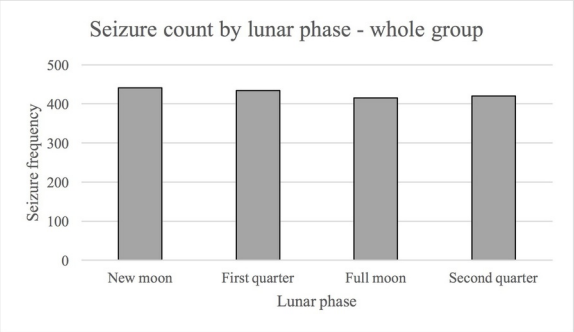

Figure 1. Seizure count by lunar phase – whole group analysis

IMJ_15135_figure 1 Lunar seizures.jpg