SVOA Dentistry

e-ISSN 2753-9172

ScienceVolks Open Access

Literature Review

# Perspectives in Dental Neuroscience: Interdisciplinary Evidence between Bruxism and Environmental Electromagnetic Variations

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https://doi.org/10.58624/SVOADE.2026.07.009

**Received:** February 19, 2026

**Published:** March 06, 2026

Citation: de Mello DNP, Pedron IG. Perspectives in Dental Neuroscience: Interdisciplinary Evidence between Bruxism and Environmental Electromagnetic Variations. *SVOA Dentistry* 2026, 7:2, 63-67. doi: 10.58624/SVOADE.2026.07.009

## Abstract

Bruxism is a multifactorial neuromuscular disorder characterised by teeth clenching or grinding. Its aetiology involves psychosocial, genetic, and neurological factors. Recent advances in sleep neuroscience and chronobiology have broadened our understanding of its central pathophysiological mechanisms. At the same time, the hypothesis has emerged in the literature that environmental electromagnetic oscillations, such as those originating from solar and geomagnetic activity, may modulate the homeostasis of the autonomic nervous system and circadian rhythms. The purpose of this study is to review the literature connecting dentistry, neuroscience, and geophysics, exploring the neurophysiological mechanisms that potentially mediate the relationship between natural electromagnetic fields and the exacerbation of bruxism. The analysis suggests that changes in melatonin secretion, dopaminergic dysfunction, and autonomic instability triggered by circadian disturbances may constitute plausible links between environmental electromagnetic activity and orofacial neuromotor disorders. Although direct evidence is limited, the accumulation of indirect data supports the biological plausibility of this interaction, signalling a promising field for future investigations.

***Keywords:*** *Bruxism; Neurosciences; Sleep Wake Disorders; Temporomandibular Joint Dysfunction Syndrome.*

## Introduction

Bruxism remains a challenge in clinical practice due to its multifactorial and complex nature[1,2]. Traditionally, its pathogenesis is attributed to psychological factors (stress, anxiety), genetic predispositions, and sleep comorbidities[2,3]. Recent consensus and neuroimaging reviews consolidate the role of REM sleep fragmentation, alterations in nigrostriatal dopaminergic circuits, and autonomic nervous system hyperactivity as central mechanisms[4-6]. Additionally, serotonergic modulation and hypothalamic-pituitary-adrenal axis activity are recognised as significant influences on the occurrence of bruxism episodes[7,8].

In a broader context, attention to the influence of extrinsic environmental variables on human physiology has grown. Natural electromagnetic oscillations resulting from solar and geomagnetic storms have been correlated with changes in cardiovascular, psychiatric, and autonomic regulation parameters[9-13]. These findings raise the hypothesis that environmental electromagnetic activity may indirectly modulate the risk and intensity of bruxism by destabilising already vulnerable neural systems[14-17].

There is an additional conceptual substrate that has been proposed: the temporal dynamics of neural networks themselves may be aligned with external electromagnetic patterns. The rhythmic 'signature' of the brain, especially in the theta-alpha bands, may have established, over the course of evolution, a functional sensitivity to the natural oscillations of the Earth-ionosphere field. Spectral data show similarity between electroencephalographic power peaks in these bands and the fundamental frequencies of Schumann resonances, suggesting that such resonances could act as an environmental synchronisation signal for neurophysiological rhythms[18-20].

The purpose of this study is to critically integrate evidence from three domains: (1) the clinical neuroscience of bruxism, based on recent consensus; (2) chronobiology and sleep science, which elucidate how environmental factors can influence biological rhythms; and (3) geophysics, which provides data on variations in the Earth's electromagnetic field. Through this interdisciplinary synthesis, we discuss the plausibility of a connection between electromagnetic activity and bruxism, proposing a layered model that distinguishes consolidated evidence from emerging hypotheses.

## Review of the Literature

### Bruxism and Clinical Neuroscience

The contemporary classification divides bruxism into sleep bruxism and awake bruxism, according to the International Classification of Sleep Disorders (ICSD-3)[3]. Sleep bruxism is strongly associated with micro-awakenings, changes in heart rate variability, and fragmentation of REM sleep[4,8]. The awake form is predominantly related to states of high alertness and emotional tension[7,8]. Recent reviews have reaffirmed that the dopaminergic system plays a central role in modulating involuntary orofacial motor activity, both during sleep and wakefulness[5,6]. Similarly, dysfunctions in serotonergic modulation, closely linked to mood and stress, can amplify the frequency and intensity of bruxism episodes[7,8,17,21]. This neurobiological basis, centred on neurotransmitters and sleep regulation, constitutes the fundamental level for understanding the disorder.

### Circadian Rhythms, Sleep, and Environmental Influences

Circadian rhythms, orchestrated by the suprachiasmatic nucleus and synchronised by environmental cues such as light, are critical for regulating the sleep-wake cycle and neuroendocrine processes[22,23]. Melatonin production by the pineal gland is one of the central effectors of this system. Disturbances in these rhythms (chronodisruption) are recognised risk factors for a number of disorders, including sleep disorders and, by extension, bruxism[8,22]. Evidence shows that exposure to factors that disrupt chronobiology, such as light at inappropriate times or abrupt changes in routine, can lead to insomnia, sleep fragmentation, and autonomic instability[23], and subsequently to sleep bruxism[3,4,8]. From this perspective, generic environmental factors can impact the physiology relevant to bruxism.

### Electromagnetic Oscillations and the Nervous System: An Exploratory Hypothesis

Solar and terrestrial geomagnetic activity has been associated with subtle effects on human physiology. Observational studies correlate periods of high geomagnetic activity with reduced melatonin secretion[13], changes in heart rate variability[11], and a higher incidence of depressive episodes and emotional instability[14]. Such effects are potentially mediated by neuroendocrine and autonomic pathways[15-17].

A plausible mechanism links environmental electromagnetic modulation with changes in melatonin secretion and autonomic stability. These pathways impact sleep architecture and orofacial motor behaviour. Studies associated peaks in geomagnetic activity with reduced nocturnal excretion of melatonin metabolites in humans, and experimental simulations of abrupt increases in geomagnetic activity produced measurable variations in electroencephalogram spectral power[13,25,26].

One proposed biophysical mechanism involves Schumann resonances - global electromagnetic waves in the Earth-ionosphere cavity - with fundamental frequencies close to alpha brain rhythms (approximately 7.83Hz), associated with relaxation and the transition to sleep[18-20]. Changes in the intensity or stability of these frequencies, caused by geomagnetic storms, could interfere with this synchronisation, contributing to sleep fragmentation and autonomic dysfunctions[18-20,25,26].

### Interdisciplinary Evidence and Gaps

Studies integrating geophysics and population health indicated correlations between peaks in geomagnetic activity and high rates of psychiatric hospitalisations, suicides, and autonomic dysfunctions[24,27], reinforcing the notion that the human nervous system may be sensitive to these variables. Chronobiology, as advocated by Halberg and colleagues[28], should be incorporated into the interpretation of human pathophysiology, providing a conceptual framework for this approach.

However, major gaps remain: (1) the near absence of longitudinal clinical trials that directly correlate bruxism metrics (quantified polysomnography) with real-time geomagnetic activity data[11-14]; (2) the lack of valid biomarkers to quantify exposure and individual susceptibility to these oscillations[15-20,25,26]; and (3) the scarcity of structured interdisciplinary collaborations that integrate methodologies from dentistry, neuroscience, and geophysics[9,10,24,27,28].

## Discussion

This article proposes a stratified model for understanding the aetiology of bruxism. The fundamental layer (Level 1) consists of neurobiological, psychological, and genetic factors consolidated in recent literature[1,6,21]. On this basis, the mediation layer (Level 2) involves circadian rhythms and sleep regulation, which are sensitive to more conventional environmental disturbances (light, social schedules), as established by chronobiology[22,23]. Finally, the exploratory layer (Level 3) proposes that specific variations in the natural electromagnetic environment may be one of these disturbances, potentially capable of exacerbating the autonomic instability and sleep fragmentation that underlie bruxism[9-20,25,26].

Plausible mechanisms for this interaction include suppression of melatonin secretion by geomagnetic activity[13,15-17], which in turn disrupts the sleep-wake cycle; exacerbation of dopaminergic dysfunction[4,5]; and induction of instability in the autonomic nervous system[4,5,15-17]. The argument is strengthened by indirect evidence showing that the same factor (sleep disturbance) is both a proposed consequence of geomagnetic activity[14,25,26] and a known risk factor for bruxism[3,4,8].

The current clinical management of bruxism should remain anchored in evidence-based multifactorial strategies: stress control, use of interocclusal devices when indicated, and addressing concomitant sleep disorders[1,2,7]. However, consideration of broader environmental factors, including the electromagnetic hypothesis, expands the research horizon. In the future, confirmation of these interactions may pave the way for more integrated preventive strategies, such as the development of more protected sleep environments or the consideration of more robust chronotherapies.

Taking this hypothesis a step further, cellular studies and reviews on the effects of extremely low frequency electromagnetic fields (ELF-EMF) with aproximately 1-100 Hz), indicate that stimuli in this range can modulate cellular processes relevant to neuronal development, including proliferation, differentiation, and synaptic plasticity in *in vitro* and animal models. Thus, it is plausible that, throughout human evolution, stable environmental electromagnetic patterns have functioned as synchronising cues that contributed to the ontogenesis and fine-tuning of neural network frequencies. Abrupt variations in these cues could therefore disrupt maturation processes or functional stability in susceptible individuals[29].

## Conclusions

Bruxism is a complex condition that requires an integrated understanding of psychological, neurological, and, increasingly, environmental aspects. The reviewed evidence indicates that it is biologically plausible that environmental electromagnetic oscillations may indirectly impact the central nervous system, modulating circadian rhythms and key autonomic mechanisms involved in the pathogenesis of bruxism. Despite the urgent need for specific clinical studies to confirm and quantify this relationship, the interdisciplinary approach proposed here points to an innovative field of research. Rigorous exploration of this hypothesis has the potential to transform not only the understanding of the triggers of bruxism, but also to contribute to a more holistic view of human health in interaction with its geophysical environment.

## Conflict of Interest

The authors declare that they have no conflict of interest.

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