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Original Article

Bad sleep? Don't blame the moon! A population-based study

José Haba-Rubio [a], Pedro Marques-Vidal [b], Nadia Tobback [a], Daniela Andries [a], Martin Preisig [c], Christine Kuehner [d], Peter Vollenweider [b], Gérard Waeber [b], Gianina Luca [e], Mehdi Tafti [a,e], Raphaël Heinzer [a,f,*]

[a] Center for Investigation and Research in Sleep (CIRS), Lausanne University Hospital (CHUV), Lausanne, Switzerland
[b] Department of Medicine, Internal Medicine, Lausanne University Hospital (CHUV) and Faculty of Biology and Medicine, Lausanne, Switzerland
[c] Department of Psychiatry, Lausanne University Hospital (CHUV), Lausanne, Switzerland
[d] Research Group Longitudinal and Intervention Research, Department of Psychiatry and Psychotherapy, Central Institute of Mental Health, Medical Faculty Mannheim, Heidelberg University, Germany
[e] Center for Integrative Genomics, Lausanne University, Lausanne, Switzerland
[f] Pulmonary Department, Lausanne University Hospital (CHUV), Lausanne, Switzerland

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ABSTRACT

Introduction: The aim of this study was to evaluate if there is a significant effect of lunar phases on subjective and objective sleep variables in the general population.
Methods: A total of 2125 individuals (51.2% women, age 58.8 ± 11.2 years) participating in a population-based cohort study underwent a complete polysomnography (PSG) at home. Subjective sleep quality was evaluated by a self-rating scale. Sleep electroencephalography (EEG) spectral analysis was performed in 759 participants without significant sleep disorders. Salivary cortisol levels were assessed at awakening, 30 min after awakening, at 11 am, and at 8 pm. Lunar phases were grouped into full moon (FM), waxing/waning moon (WM), and new moon (NM).
Results: Overall, there was no significant difference between lunar phases with regard to subjective sleep quality. We found only a nonsignificant ($p = 0.08$) trend toward a better sleep quality during the NM phase. Objective sleep duration was not different between phases (FM: 398 ± 3 min, WM: 402 ± 3 min, NM: 403 ± 3 min; p = 0.31). No difference was found with regard to other PSG-derived parameters, EEG spectral analysis, or in diurnal cortisol levels. When considering only subjects with apnea/hypopnea index of <15/h and periodic leg movements index of <15/h, we found a trend toward shorter total sleep time during FM (FM: 402 ± 4, WM: 407 ± 4, NM: 415 ± 4 min; $p = 0.06$) and shorter-stage N2 duration (FM: 178 ± 3, WM: 182 ± 3, NM: 188 ± 3 min; $p = 0.05$).
Conclusion: Our large population-based study provides no evidence of a significant effect of lunar phases on human sleep.

1. Introduction

"...her power to enamour, to mortify, to invest with beauty, to render insane, to incite to and aid delinquency..." Ulysses, James Joyce.

In human history and in different cultures, there has been a strong belief that the moon can have an effect on health, including sleep, with people reporting difficulty in falling and remaining asleep when the moon is full. Increased nightlight during full moon (FM) could partly explain these complaints when humans slept in caves, but this would not hold in our modern curtained homes.

An evidence of the effect of lunar cycles on human biology and sleep was reported to be largely based on folklore or myths, with little robust scientific evidence [1]. Nevertheless, more recent studies based on either sleep electroencephalography (EEG) or subjective sleep evaluations have yielded conflicting results [2–6]. This might be due to the fact that not all key variables have been controlled, and that further studies are required [7].

Thus, our study aimed to focus on the possible effects of the lunar cycle on sleep. We analyzed subjective sleep quality and objective sleep duration and structure in a large, random, middle-aged general population sample. In a subgroup of individuals without significant sleep disorders and free of sleep medication or significant alcohol consumption, EEG microstructure was also analyzed by spectral analysis. As some studies suggested that moon phases could affect mood and consequently sleep, salivary cortisol as a measure of biological stress response, was also evaluated.

* Corresponding author. Center for Investigation and Research in Sleep (CIRS), Lausanne University Hospital (CHUV), Rue du Bugnon 46, Lausanne, Switzerland. Tel.: +41 213146748; fax: +41 213146752.
E-mail address: raphael.heinzer@chuv.ch (R. Heinzer).

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2. Methods

2.1. Study design

The HypnoLaus Sleep study is based on the first follow-up of the epidemiologic CoLaus/PsyCoLaus study described earlier [8–10]. Briefly, the CoLaus study included a random sample of 6733 individuals (range age: 35–75 years), who were residents of Lausanne (Switzerland), between 2003 and 2006. The distribution of age groups, gender, and zip codes of the participants was similar to that of the source population [8]. The main aim of this cohort study was to investigate the presence of cardiovascular risk factors in the general population and to identify their genetic determinants. All participants also underwent an extensive psychiatric evaluation (PsyCoLaus) [10]. HypnoLaus evaluated the subjective and objective sleep characteristics of this population [9]. During the first follow-up of the cohort, five years after baseline, the responded individuals underwent a new physical ($n = 5064$) and psychiatric ($n = 4002$) examination, and were given questionnaires by trained interviewers, which included questions on demographic, medical, and treatment history as well as smoking and alcohol consumption. Sleep-related complaints and habits were investigated using the Pittsburgh Sleep Quality Index [11], the Epworth Sleepiness Scale [12], and the Berlin Questionnaire for sleep-disordered breathing [13]. The CoLaus/PsyCoLaus and HypnoLaus studies were approved by the Ethics Committee of the University of Lausanne, and a written informed consent was obtained from all participants at the baseline and for the follow-up assessments.

2.2. Polysomnography

A total of 3051 consecutive CoLaus/PsyCoLaus subjects were invited to undergo a full night in-home polysomnographic recording, of which only 71.1% accepted. These individuals were of similar age (–0.3 years) and gender (+1.6% males) to those of the whole CoLaus cohort. The selection of individuals was made regardless of the results of sleep questionnaires. During their visit at the Center for Investigation and Research in Sleep (University Hospital of Lausanne, Switzerland) between 5 and 8 pm, certified technicians equipped the subjects with a PSG recorder (Titanium, Embla® Flaga, Reykjavik, Iceland). All sleep recordings were performed in the subject's home, and included a total of 18 channels: EEG (F3/M2, F4/M1, C3/M2, C4/M1, O1/M2, and O2/M1), right and left electrooculography, surface electromyography channels (one submental region, two anterior tibialis muscles), electrocardiogram, nasal pressure, thoracic and abdominal respiratory inductance belts, body position, oxygen saturation, and pulse rate [14].

All PSG recordings were visually made by two trained sleep technicians (DA and NT) using Somnologica software (version 5.1.1, Embla® Flaga, Reykjavik, Iceland), and reviewed by a trained sleep physician (JHR). Random quality checks were performed by a second physician (RH). Quality control for concordance rate between the two PSG scorers was implemented periodically to ensure that both scorers achieved at least 90% level of agreement for sleep stages and respiratory events and 85% level of agreement for arousals [15]. Sleep stages and arousals were determined according to the 2007 American Association of Sleep Medicine (AASM) criteria [14]. The oxygen desaturation index (ODI) represents the number of times per hour of sleep that the blood's oxygen level drops by ≥3% from baseline. Apneas/hypopneas were determined according to the AASM 2013 rules [16]. The average number of apneas/hypopneas per hour of sleep (apnea/hypopnea index, AHI) was calculated. Periodic leg movements (PLMs) during sleep were determined according to the official World Association of Sleep Medicine standards [17], and expressed as the number of PLMs per hour of sleep (Periodic Leg Movements during Sleep, PLMSI).

2.3. Sleep EEG spectral analysis

Sleep microstructure was analyzed using sleep EEG spectral analysis in a subgroup of the population, selected on the basis of the absence of medication for sleep disorders (sleeping pills, antidepressants, or neuroleptics), <2 glasses of wine consumed 4 h before sleep, sleep duration >5 h, sleep efficiency >80%, AHI <15/h, and PLMSI <15/h. Signals were filtered by a high-pass filter (EEG and EOG: –3 dB at 0.5 Hz; EMG: 10 Hz), a low-pass filter (EEG: –3 dB at 35 Hz, EMG: 70 Hz), and a notch filter at 50 Hz. Data were sampled at 256 Hz. The EEG power spectra of consecutive 30-s epochs (average of 4-s epochs interval with a 50% overlap, fast Fourier transform routine, Hamming window, frequency resolution 0.25 Hz) for nonrapid eye movement (NREM) sleep (stages N2 and N3) and rapid eye movement (REM) sleep were calculated using PRANA® software (PhiTools, Strasbourg, France). All artifacts were removed from spectral analysis. NREM–REM cycles were defined according to Feinberg and Floyd [18]. NREM/REM spectral analysis was conducted only for the maximum first four sleep cycles. Delta (0.75–4.5 Hz), theta (4.75–8 Hz), alpha (8.25–11 Hz), slow spindles (11.25–13 Hz), fast spindles (13.25–15 Hz), and beta (15–25 Hz) bands were calculated. EEG power spectra were normalized by dividing the power in each 0.25-Hz bin by the total power for NREM and REM sleeps over the frequency range of 0.75–30 Hz.

2.4. Subjective sleep quality

Subjective sleep quality of the recorded night was evaluated by the participants with a self-rating scale, immediately after awakening in the morning. Sleep quality was rated in four categories: "Excellent," "Good," "Average," or "Bad." In addition, for analysis, the subjects were split into two groups: subjects who reported "Excellent" and "Good" sleep qualities versus those who reported "Average" and "Bad" sleep qualities. Alcohol consumption and sleep medication intake before the PSG recording were also documented.

2.5. Cortisol levels

Participants of the first psychiatric follow-up investigation received little swabs (Salivette, Sarstedt, Leicester, UK) for salivary cortisol collection at awakening, 30 min thereafter, at 11 am and 8 pm. Cortisol measurements were made independently from the PSG. The cortisol analyses refer to the actual moon phase when the probes were taken. Saliva cortisol samples were collected using cotton swabs ("Salivette," Sarstedt), immediately frozen at –20 °C, and sent for biochemical analysis. Then, they were centrifuged at 3000 rpm for 5 min, which resulted in a clear supernatant of low viscosity. Salivary cortisol concentrations were measured using commercially available chemiluminescence immunoassay with high sensitivity (IBL International, Hamburg, Germany), and intra- and interassay coefficients of variation <8%, as described earlier [19,20]. We compared the cortisol levels at awakening, the cortisol awakening response (calculated by subtracting cortisol at time 1 from cortisol at time 2), and the average of the four measures between the three groups.

2.6. Lunar phases

Moon phases of Lausanne were obtained for the different dates of interest from www.timeanddate.com/worldclock/astronomy.html. Unavailable values (which occurred in <1% of cases) were found by extrapolating from the two adjacent ones. As some authors have suggested that the effect of moon could be due to a "tidal effect," the average distance between the moon and the Earth (km) was also collected for each day. Lunar phases were divided, as previously [2,5], into full moon (FM) (±4 nights from FM), waxing/waning moon