ESI Preprints **Not Peer-reviewed**

Association Between Stimulant Use, Sleep Disorders, and Daytime Sleepiness Among Shift Workers in a Mine in Senegal

Assega Sylvain Sagna, MD
Boto SA, Managem Group, Kédougou, Senegal
Ndeye Marame Wade, MD
Ibrahima Adama Aw, MD
Mota-Engil, Kédougou, Senegal
Joseph Khoulanso Sambou, MD
MCI, Kédougou, Sénégal

Approved: 11 September 2026
Posted: 13 September 2026

Cite As:
Sagna, A.S., Wade, N.M., Aw, I.A. & Sambou, J.K. (2026). *Association Between Stimulant Use, Sleep Disorders, and Daytime Sleepiness Among Shift Workers in a Mine in Senegal*. ESI Preprints. https://doi.org/10.19044/esipreprint.9.2026.p488

Abstract

Objective : To assess the association between stimulant use, sleep disorders, and daytime sleepiness in among workers on 12-hour rotating shift in a gold mine in Senegal. **Materials :** Analytical cross-sectional study conducted within a gold-mining project. A questionnaire was administered after free and informed consent. Analysis was performed using Epi Info with logistic regression adjusted for age. **Results :** Among 227 workers, 58.1% reported a sleep disorder and 12.3% daytime sleepiness. Coffee was the most used stimulant (68.7%); 56.8% used a single product. No isolated stimulant was associated with sleep disorders. Concurrent use of at least two stimulants was independently associated with sleep-onset difficulty (aOR 2.31; 95% CI 1.05–5.08). Conclusion: It is not isolated stimulant use that is problematic, but rather their combination, which impairs sleep onset.

Keywords: Shift work; sleep disorders; daytime sleepiness; caffeine; mining; Senegal

Introduction

In the mining sector, the need to maintain continuous operations around the clock throughout the day and year has led to a shift-based work organization with rotating schedules *(weeks on, weeks off)* (Barthe, 2009). In Senegal, the 12-hour rotating shift alternating night work and day work is widely favored. This work organization exposes workers to sleep disturbances and increased levels of excessive daytime sleepiness (Weibel, 2026). Indeed, non-standard working hours, with or without night work, have well-documented adverse health effects due to sleep debt, chronic stress, and disruption of life rhythms. These effects are also observed with regard to occupational safety (Léger et al., 2009, 2018; Sauvagnac et al., 2014). To mitigate these effects, workers tend to use stimulants with the aim of maintaining an adequate level of alertness (caffeine, tobacco, energy drinks, etc.) (Cardinaels, 2011; Vergez et al., 2020). These stimulants can indeed provide beneficial short-term effects on alertness (Hamadouche & Abed, 2026; Langevin, 2026).

However, while the effects of shift work and night work are well described, the association between stimulant use, sleep disorders, and daytime sleepiness is less well documented in the literature. Yet, other studies argue that these substances can both mask sleepiness and worsen sleep fragmentation, with potential consequences for occupational safety (Langevin, 2026; Sicard, 2002).

The objective of this study was to assess the association between psychostimulant substance use, the prevalence of the various sleep disorders, and daytime sleepiness among workers on 12-hour rotating shifts in a mine in Senegal.

Materials and Methods

This study is an analytical cross-sectional study conducted within a gold-mining project between February 16, 2026, and March 31, 2026.

Population and Eligibility Criteria

Exhaustive (total-population) sampling.

- **Source population:** shift workers at the site (2-on/1-off rotation, 12 h × 2).
- **Inclusion criteria:** working a 12-hour rotating shift and having at least 3 months of seniority.
- **Exclusion criteria:** subcontractors and workers with less than 3 months of seniority.

Tools and Measurement Quality

The structured questionnaire was developed on the basis of a literature review and ILO/WHO recommendations. Information on sleep disorders and stimulant use was self-reported. A pretest was conducted, and interviewers were trained to assist non-literate participants fill the questionnaire.

Data Collection Procedure

The questionnaire was administered directly, either self-completed or with the assistance of a trained interviewer. Free and informed consent was obtained prior to administration, and responses were anonymized.

Operational Definitions of Variables

- **Daytime sleepiness:** Sleepiness is characterized by the occurrence, during the work shift (sometimes during the day, sometimes at night), of involuntary and disabling episodes of sleep.
- **Sleep-onset difficulty** : difficulty initiating sleep during the past 2 weeks
  - Frequent awakenings : waking up at least twice per sleep period, at least three times a week, during the past 2 weeks.
  - Early awakenings : waking up at least one hour before the intended time without being able to fall back asleep, at least three times a week, during the past 2 weeks
- **Coffee consumption:** Drinking at least one cup of coffee per shift and while at work.
- **Tobacco use:** smoking at least one cigarette per shift and while at work.
- **Energy drink consumption :** drinking at least one cane of energy drink while at work
- **Multiple stimulant use :** concurrent use of at least two of the three products

Data Processing

Data were entered in Microsoft Excel and exported to Epi Info 7.0 for analysis, with a significance threshold set at $p < 0.05$. Associations were tested using the chi-square test or Fisher's exact test when expected counts were below 5. Variables with $p < 0.20$ in bivariate analysis were entered into age-adjusted logistic regression models.

Results

All workers meeting the inclusion criteria returned a usable questionnaire, giving a response rate of 100%. The characteristics of this population are described in Table 1.

Table 1: Sociodemographic characteristics of the study population (N = 227)

Variable	Category	N	Percentage (%)
Sex	Male	218	96%
	Female	09	04%
Physical activity	Regular	162	71.4%
	Occasional	65	28.6%
Educational level	None	15	6.6%
	Primary	60	26.4%
	Secondary	117	51.5%
	University	35	15.4%
Age (years)	Mean (± SD)	34.4 (7.1)	
	Maximum	56	
	Minimum	19	
Seniority (months)	Mean (± SD)	18 (4.7)	
	Maximum	35	
	Minimum	04	

The psychoactive substances investigated included coffee, energy drinks, tobacco, and alcohol. As shown in Table 2, coffee was the most commonly used substance. Alcohol consumption was nonetheless marginal and was therefore not subsequently considered a stimulant.

Table 2: Prevalence of psychoactive substance use

Substance	Category	n	Percentage (%)
Coffee	Yes	156	68.7%
	No	71	31.3%
Energy drink	Yes	88	38.8%
	No	139	61.2%
Tobacco	Yes	37	16.3%
	No	190	83.7%
Alcohol	Yes	4	1.8%
	No	223	98.2%

Most workers reported exclusive use of a single stimulant — coffee, energy drinks, or tobacco — for a total proportion of 56.8%. See Table 3.

Table 3: Consumption profile of shift workers

Consumption profile	n	Percentage (%)
No consumption		
• No stimulant	29	12.8%
Exclusive consumption		
• Coffee alone	91	40.1%
• Energy drink alone	34	15%
• Tobacco alone	4	1.8%
Multiple stimulant use– 2 products		

• Coffee + tobacco	15	6.6%
• Coffee + energy drink	36	15.9%
• Tobacco + energy drink	4	1.8%
Multiple stimulant use– 3 products		
• Coffee + energy drink + tobacco	14	6.2%

The prevalence of sleep disorders was 58.1%. These were dominated by frequent awakenings, i.e., fragmented sleep. Daytime sleepiness had a prevalence of 12.3%. Figure 1 describes these results.

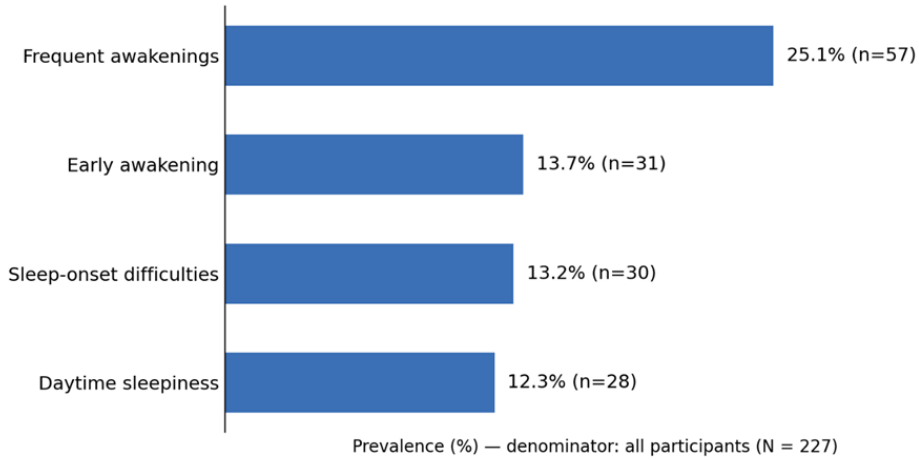

Figure 1: Frequency of the various sleep disorders and of daytime sleepiness

In bivariate analysis, the stimulants studied did not appear to be associated with sleep disorders, as shown in Table 4.

Table 4: Bivariate analysis of factors associated with overall sleep disorder

Factor studied	Disorder present (n=132)	Disorder absent (n=95)	p-value
Coffee			0.171
Yes	86 (55.1%)	70 (44.9%)	
No	46 (64.8%)	25 (35.2%)	
Energy drink			0.182
Yes	56 (63.6%)	32 (36.4%)	
No	76 (54.7%)	63 (45.3%)	
Tobacco			0.859
Yes	22 (59.5%)	15 (40.5%)	
No	110 (57.9%)	80 (42.1%)	
Polysubstance use			0.797
Yes	41 (59.4%)	28 (40.6%)	
No	91 (57.6%)	67 (42.4%)	

In contrast, detailed analysis of insomnia subtypes revealed that early morning awakenings were significantly less frequent among smokers than non-smokers (2.7% vs. 15.8%; p = 0.035). No significant association was

found between any of the isolated substances (coffee, tobacco, energy drinks) and either Sleep-onset difficulties or frequent nocturnal awakenings.

Similarly, multiple stimulant use(more than one stimulant) was not significantly associated with the overall sleep-disorder complaint. However, it was associated with difficulty initiating sleep. Indeed, sleep-onset difficulties were significantly more frequent among workers using at least two substances (20.3%) than among exclusive users or abstainers (10.1%); p = 0.037.

Likewise, neither isolated stimulant use nor multiple stimulant use appeared to be related to daytime sleepiness (Table 5).

Table 5: Bivariate analysis of factors associated with daytime sleepiness

Factor studied	Daytime sleepiness present (n=28)	Daytime sleepiness absent (n=199)	p-value
Coffee			0.741
Yes	20 (12.8%)	136 (87.2%)	
No	08 (11.3%)	63 (88.7%)	
Energy drink			0.086
Yes	15 (17%)	73 (83%)	
No	13 (9.3%)	126 (90.7%)	
Tobacco			0.419*
Yes	6 (16.2%)	31 (83.8%)	
No	22 (11.6%)	168 (88.4%)	
Polysubstance use			0.125
Yes	12 (17.4%)	57 (82.6%)	
No	16 (10.1%)	142 (89.9%)	

*Fisher's exact test used

To rule out potential confounding factors, a multivariate logistic regression analysis was performed to examine overall factors associated with sleep disorder (Table 6). After adjustment for participants' age, neither coffee consumption (aOR = 0.76; 95% CI [0.41–1.39]; p = 0.379) nor energy drink consumption (aOR = 1.30; 95% CI [0.73–2.28]; p = 0.363) emerged as significantly associated with an overall complaint of sleep disorder.

Table 6: Multivariate analysis (logistic regression) of factors associated with overall sleep disorder

Variable studied	Category	Adjusted OR*	95% CI	p-value
Coffee	No (Ref)	1	–	–
	Yes	0.76	[0.41–1.39]	0.379
Energy drink	No (Ref)	1	–	–
	Yes	1.30	[0.73–2.28]	0.363

*The model was adjusted for participants' age

Multivariate analysis of the factors associated with daytime sleepiness (Table 7) did not reveal any statistically significant association at the 5% threshold. A strong trend was nonetheless noted for energy drink

consumption, which appeared to nearly double the risk of daytime sleepiness complaints (aOR = 2.16)

Table 7: Multivariate analysis (logistic regression) of factors associated with daytime sleepiness

Variable studied	Category	Adjusted OR*	95% CI	p-value
Energy drink	No (Ref)	1	–	–
	Yes	2.16	[0.96–4.88]	0.063
Polysubstance use	No (Ref)	1	–	–
	Yes	1.84	[0.82–4.14]	0.140

*The models were adjusted for participants' age.
To avoid collinearity bias, energy drink consumption and Multiple stimulant usewere tested in two separate multivariate models.

Multivariate analysis specific to the three insomnia criteria (Table 8) revealed differences according to the symptoms studied. For Sleep-onset difficulties, multiple stimulant use of stimulants emerged as a significant risk factor (aOR = 2.31; 95% CI [1.05–5.08]; p = 0.037), while exclusive tobacco use showed a trend bordering on significance (aOR = 2.26; p = 0.079). In contrast, coffee consumption was not significantly associated with complaints of frequent awakenings (p = 0.416). Finally, for early awakening, the analysis found an inverse trend with smoking (aOR = 0.14; p = 0.055).

Table 8: Multivariate analysis (logistic regression) of factors associated with specific sleep disorders

Symptom / factor studied	Category	Adjusted OR*	95% CI	p-value
Sleep-onset difficulties				
• Tobacco	No (Ref)	1	–	–
	Yes	2.26	[0.91–5.64]	0.079
• Multiple stimulant use	No (Ref)	1	–	–
	Yes	2.31	[1.05–5.08]	0.037
Frequent awakenings				
Coffee	No (Ref)	1	–	–
	Yes	0.76	[0.40–1.46]	0.416
Early awakening				
• Tobacco	No (Ref)	1	–	–
	Yes	0.14	[0.02–1.05]	0.055
• Polysubstance use	No (Ref)	1	–	–
	Yes	0.5	[0.19–1.27]	0.146

*The models were adjusted for participants' age.
Collinearity bias was avoided.

Discussion

Our study, based on exhaustive (total-population) sampling, was conducted among a workforce representative of the mining sector. The population studied was predominantly male, with a mean age of around 35 years (Sagna et al., 2025). The mean seniority in the position, of 18 months, is consistent with the relatively young age of the mine studied: construction of this mine began in 2024 and operations started in 2025.

Shift work, organized in 12-hour shifts, is widespread there, particularly in the production and processing (plant) departments. This work organization is consistent with what has been reported in the occupational health and safety literature, notably in Africa and Australia (Hinson et al., 2021; Smith et al., 1998). The psychosocial and physical constraints associated with extended shift schedules are well documented and includes sleep debt, sleep disorders, and daytime sleepiness (Barthe, 2009; Léger et al., 2018; Weibel, 2026). These constraints lead workers to use psychoactive substances "to keep fit", in an attempt to compensate for fatigue and maintain a satisfactory level of alertness in order to carry out their tasks.

Coffee is by far the most widely consumed psychostimulant in our study, consistent with what is observed in the general population (Guénolé et al., 2011; Sicard, 2002). Coffee has been consumed for centuries. The earliest written accounts of its exciting and stimulant effects reportedly date back to the ninth century, and the "wakefulness molecule" (caffeine) was not isolated until 1820, by German chemists (Sicard, 2002). Coffee's alertness-enhancing properties were the first to be described and remain the most extensively studied (Drake et al., 2013; Sicard, 2002). Energy drink consumption is also not negligible: in Algeria, a study showed that it is becoming increasingly widespread, particularly among young people (Chefirat et al., 2015), whereas tobacco use appears to be declining (Guénolé et al., 2011). The effects of these stimulants depend on the dose consumed and, depending on the time of intake, can disrupt sleep quality at bedtime (Drake et al., 2013; Karacan et al., 1976).

In our study, the prevalence of sleep disorders was 58.1%, indicating that more than one worker in two experience poor sleep quality, with sleep most often being fragmented.

However, no significant association was found between sleep disorders and coffee or energy drink consumption. Unexpectedly, the findings suggested an inverse association between tobacco use and early awakening, significant in bivariate analysis ($p = 0.035$) but only borderline after adjustment for age (aOR = 0.14; $p = 0.055$). This finding should be interpreted with caution given the small size of smokers involved in the study, and therefore a probable limited statistical power. Moreover, the literature has extensively demonstrated the negative effect of nicotine on sleep (Mauries et al., 2022).

In contrast, multiple stimulant use was associated with impaired sleep initiation. Workers who consumed at least two of the three psychostimulants had 2.31-fold higher odds of sleep-onset difficulties.

These findings suggest that the adverse effect of these stimulants on sleep is not attributable to the use of one single substance, but rather the combination of these. This finding is consistent with the literature, which

describes how the combination of different mechanisms of action on the central nervous system maintains a prolonged state of hyperarousal (Spadola et al., 2019). Although workers may derive short-term benefits of the alertness-enhancing effects from these substances during working hours, these may persist, and inevitably delay sleep onset and potentially impact on subsequent shifts.

Regarding daytime sleepiness, a strong trend bordering on statistical significance ($p = 0.06$) was found in relation to energy drink consumption: the risk of daytime sleepiness tended to double among consumers of these highly caffeinated beverages. This finding may reflect a genuine vicious circle, whereby the high concentration of stimulants consumed during working hours disrupts sleep onset and fragments sleep. This results in residual, cumulative fatigue on waking, which exacerbates the risk of daytime sleepiness and drives further stimulant consumption (Roehrs & Roth, 2008).

Conclusion

Sleep disorders and excessive daytime sleepiness are common among shift workers in the mining sector. Coffee remains by far the most widely consumed stimulant used to sustain alertness during the shift. Energy drinks and tobacco are also used for this purpose. While the isolated use of coffee, energy drinks or tobacco was not significantly associated with these disorders, the concurrent use of multiple stimulants was associated with a higher prevalence of sleep-onset difficulties. These findings underline the importance of promoting the judicious use of stimulants and of implementing preventive measures aimed at improving sleep and alertness among shift workers in the mining sector.

Study limitations

Sleep disorders were assessed using a set of self-reported binary questions (daytime sleepiness, insomnia, nocturnal awakenings, early awakening) rather than validated multi-item scales (e.g., PSQI, Epworth Sleepiness Scale). Although this approach captures several key dimensions of sleep, it did not allow the severity of each symptom to be graded.

Authors contribution

- **Asséga Sylvain SAGNA**: conception and design; questionnaire; statistical analysis; drafting of the manuscript.
- **Ndèye Marame WADE**: data collection; critical revision; final approval.
- **Ibrahima Adama AW**: data collection; critical revision; final approval.

- **Joseph Khoulanso SAMBOU**: critical revision; final approval.
- **Asséga Sylvain SAGNA** is the Author who has checked every reference manually and confirmed the authenticity of every reference.

AI-use Disclosure Statement

During the preparation of this work, the authors used Claude Fable 5 (Anthropic) in order to check the consistency of the results, to translate the entire article from French into English, and to draw up the key points of the Clinical Significance section. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Conflict of Interest: The authors reported no conflict of interest.
Data Availability: All data are included in the content of the paper.

Funding Statement: The authors did not obtain any funding for this research.

Declaration for Human Participants

Consent: All participants were informed of the objectives of the study, of the anonymity of their responses and of their right to decline, and free and informed consent was obtained before administration of the questionnaire. No personal identifiers were recorded. The study was conducted in accordance with the principles of the Declaration of Helsinki. Institutional autorisation management of Mota-Engil authorised the conduct of the study on site. Clinical trial registration: Not applicable (observational cross-sectional study).

References:

1. Barthe, B. (2009). Les 2x12h : une solution au conflit de temporalités du travail posté ? *Temporalités, 10*. https://doi.org/10.4000/temporalites.1137
2. Cardinaels, J. (2011). *Travail de nuit et travail posté*. Wolters Kluwer Belgium.
3. Chefirat, B., Boukalkha, H. H., Sadji, I., & Rezk-kallah, H. (2015). Boissons énergisantes : état des connaissances et consommation chez les jeunes Algériens. *Cahiers de Nutrition et de Diététique*, *50*(1), 47–52. https://doi.org/10.1016/j.cnd.2014.07.006
4. Drake, C., Roehrs, T., Shambroom, J., & Roth, T. (2013). Caffeine effects on sleep taken 0, 3, or 6 hours before going to bed. *Journal of Clinical Sleep Medicine*, *9*(11), 1195–1200. https://doi.org/10.5664/jcsm.3170

5. Guénolé, F., Nicolas, A., Hommeril, A., Davidsen, C., & Baleyte, J.-M. (2011). Sommeil et substances à l'adolescence : les effets de la caféine, de l'alcool, du tabac et du cannabis. *Médecine du Sommeil*, *8*(4), 152–158. https://doi.org/10.1016/j.msom.2011.09.001
6. Hamadouche, M., & Abed, N. (2026). Qualité du sommeil et somnolence diurne dans une entreprise d'études techniques du secteur de la construction. *Médecine du Sommeil*, *23*(1), 75. https://doi.org/10.1016/j.msom.2025.12.120
7. Hinson, A. V., Aguemon, B., Adjobimey, M., Damien, G., Ouili, I., Mikponhoue, R., Cisse, I. M., Gounongbe, F., Ayelo, P. (2021). Prevalence and associated factors of occupational stress in the mining sector: The case study of the Youga mine at Zabre in Burkina Faso. *Occupational Diseases and Environmental Medicine*, *9*(4), 185–198. https://doi.org/10.4236/odem.2021.94014
8. Karacan, I., Thornby, J. I., Anch, A. M., Booth, G. H., Williams, R. L., & Salis, P. J. (1976). Dose-related sleep disturbances induced by coffee and caffeine. *Clinical Pharmacology & Therapeutics*, *20*(6), 682–689. https://doi.org/10.1002/cpt1976206682
9. Langevin, B. (2026). *Objectif sommeil : mode d'emploi pour mieux dormir*. Éditions de Mortagne.
10. Léger, D., Bayon, V., Metlaine, A., Prevot, E., Didier-Marsac, C., & Choudat, D. (2009). Horloge biologique, sommeil et conséquences médicales du travail posté. *Archives des Maladies Professionnelles et de l'Environnement*, *70*(3), 246–252. https://doi.org/10.1016/j.admp.2009.01.007
11. Léger, D., Esquirol, Y., Gronfier, C., & Metlaine, A. (2018). Le travail posté et de nuit et ses conséquences sur la santé : état des lieux et recommandations. *La Presse Médicale*, *47*(11–12), 991–999. https://doi.org/10.1016/j.lpm.2018.10.014
12. Mauries, S., Bertrand, L., Frija-Masson, J., Benzaquen, H., Kalamarides, S., Sauvage, K., Lejoyeux, M., D'Ortho, M., Geffroy, P. (2022). Effets du tabac sur l'architecture du sommeil et le syndrome d'apnées obstructives du sommeil (Tab-OSA). *Médecine du Sommeil*, *19*(1), 13. https://doi.org/10.1016/j.msom.2022.01.069
13. Roehrs, T., & Roth, T. (2008). Caffeine: Sleep and daytime sleepiness. *Sleep Medicine Reviews*, *12*(2), 153–162. https://doi.org/10.1016/j.smrv.2007.07.004
14. Sagna, A. S., Ndour, M. D., Gueye, M. M., & Fall, M. T. A. (2025). Pratique du quart d'heure sécurité en entreprise minière : intérêt perçu et contraintes chez les travailleurs du projet Boto au Sénégal. *Médecine d'Afrique Francophone*, 72(5), 271–280.

15. Sauvagnac, R., Barbot, F., Vaugier, I., Hartley, S., Philip, P., & Quera Salva, M.-A. (2014). Somnolence et habitudes de sommeil et conditions de travail des conducteurs poids lourds. *Médecine du Sommeil*, *11*(1), 13. https://doi.org/10.1016/j.msom.2014.01.028
16. Sicard, B. (2002). Caféine et vigilance. *Pour la Science*, 298, 46–52. http://pascal-francis.inist.fr/vibad/index.php?action=getRecordDetail&idt=13771608
17. Smith, L., Folkard, S., Tucker, P., & Macdonald, I. (1998). Work shift duration: A review comparing eight hour and 12 hour shift systems. *Occupational and Environmental Medicine*, *55*(4), 217–229. https://doi.org/10.1136/oem.55.4.217
18. Spadola, C. E., Guo, N., Johnson, D. A., Sofer, T., Bertisch, S. M., Jackson, C. L., Rueschman, M., Mittleman, M. A., Wilson, J. G, Redline, S. (2019). Evening intake of alcohol, caffeine, and nicotine: Night-to-night associations with sleep duration and continuity among African Americans in the Jackson Heart Sleep Study. *Sleep*, *42*(11), Article zsz136. https://doi.org/10.1093/sleep/zsz136
19. Vergez, A., Quiquempoix, M., Erblang, M., Van Beers, P., Guillard, M., Drogou, C., Léger, D., Chennaoui, M., Sauvet,F., Rabat, A. (2020). Fatigue cognitive induite par la privation de sommeil et le temps passé à la tâche : effets différentiels selon la tâche et bénéfice partiel du café. *Médecine du Sommeil*, *17*(1), 21. https://doi.org/10.1016/j.msom.2019.12.147
20. Weibel, L. (2026). Horaires atypiques : quelle organisation pour quels effets ? *Archives des Maladies Professionnelles et de l'Environnement*, *87*, Article 103202. https://doi.org/10.1016/j.admp.2026.103202