

# Psychosocial and Environmental Determinants of Sleep Quality: Evidence from the CitiSHealth Barcelona Panel Study

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## Introduction

- Sleep quality is influenced by psychosocial and environmental factors. Stress and alcohol consumption are common determinants of sleep disturbances, and growing evidence suggests that air pollution (e.g., PM2.5) may also impair sleep patterns.
- The CitiSHealth Barcelona Panel Study (2020–2021) provides rich self-reported and environmental exposure data that allow exploration of these relationships.

## Objective

To assess how stress, alcohol consumption, and air pollution (PM2.5) are associated with perceived sleep quality among participants in the CitiSHealth Barcelona Panel Study.

## Hypothesis

$H_0$  (Null): Stress, alcohol consumption, and PM2.5 levels are not associated with sleep quality.

$H_1$  (Alternative): Higher stress, higher alcohol consumption, and higher air pollution are associated with sleep quality.

## Data and Population

Dataset: CitiSHealth Barcelona Panel Study (2020–2021)

Study population: Adult participants providing repeated ecological momentary assessments (EMA).

Sample used: Only observations with complete data for sleep\_quality, stress, and alcohol consumption, and pm25bcn (air pollution).

Variables of interest:

- Dependent variable: (Outcome)  
• sleep\_quality (0–10 continuous scale)
- Independent variables: (Exposures)  
• stress (0–10 continuous scale)  
• alcohol consumption (Yes/No)  
• PM2.5 (pm25bcn,  $\mu\text{g}/\text{m}^3$ )
- Additional identifiers: (Covariates)  
• ID\_Zenodo (participant ID)  
• date\_all (observation date)

## Methods

### Data Preparation

- Imported Excel dataset.
- Selected variables: sleep\_quality, stress, alcohol.
- Removed incomplete cases.
- Alcohol coded as binary factor (No/Yes).

### Descriptive Analysis

- Computed means, standard deviations, and 95% confidence intervals.
- Produced summary tables stratified by alcohol consumption.

### Statistical Modeling

- Linear regression model with interaction:  
sleep\_quality ~ stress \* alcohol
- Estimated:

Main effect of stress

Main effect of alcohol

Interaction effect (stress:alcohol)

## Results

### Descriptive Statistics

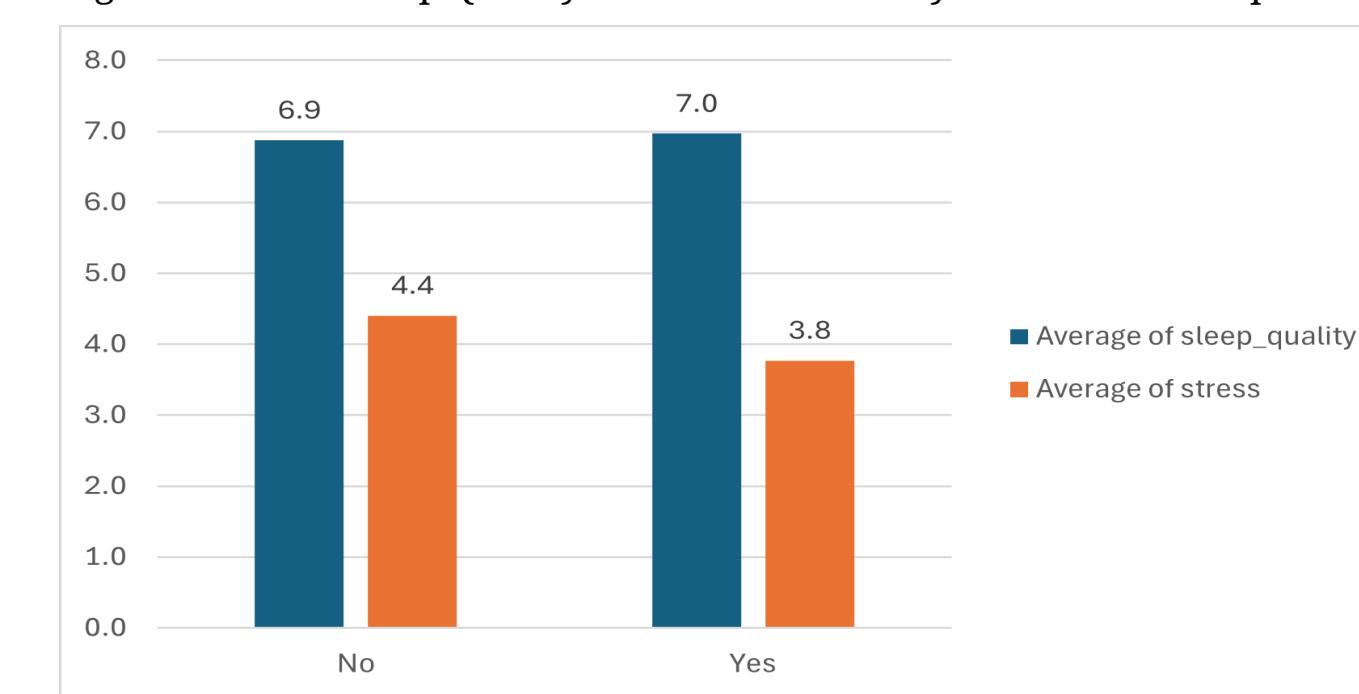
Table 1: Descriptive Comparison by Alcohol Consumption

| Alcohol | n    | Sleep Mean ± SD (95% CI)    | Stress Mean ± SD (95% CI)   |
|---------|------|-----------------------------|-----------------------------|
| No      | 2348 | 6.9 ± 2 (95% CI: 6.8–6.9)   | 4.4 ± 2.5 (95% CI: 4.3–4.5) |
| Yes     | 791  | 7.0 ± 1.9 (95% CI: 6.8–7.1) | 3.8 ± 2.4 (95% CI: 3.6–3.9) |

### Interpretation:

- Sleep quality was nearly the same in both groups (approx. 7/10).
- Stress was slightly lower among alcohol consumers.
- Differences were small and confidence intervals overlapped.

Figure 1: Mean Sleep Quality and Stress Levels by Alcohol Consumption Group



- Sleep quality was nearly identical between alcohol consumers and non-consumers, indicating that alcohol intake did not meaningfully influence perceived sleep.
- Stress levels were slightly lower among alcohol consumers, but the difference was small and unlikely to be clinically significant.

Figure 2: Distribution of Sleep Quality by Alcohol Consumption



- Median sleep and variation were nearly identical for both alcohol groups.
- Indicates minimal effect of alcohol on sleep.

Figure 3: Interaction Between Stress and Alcohol on Sleep Quality

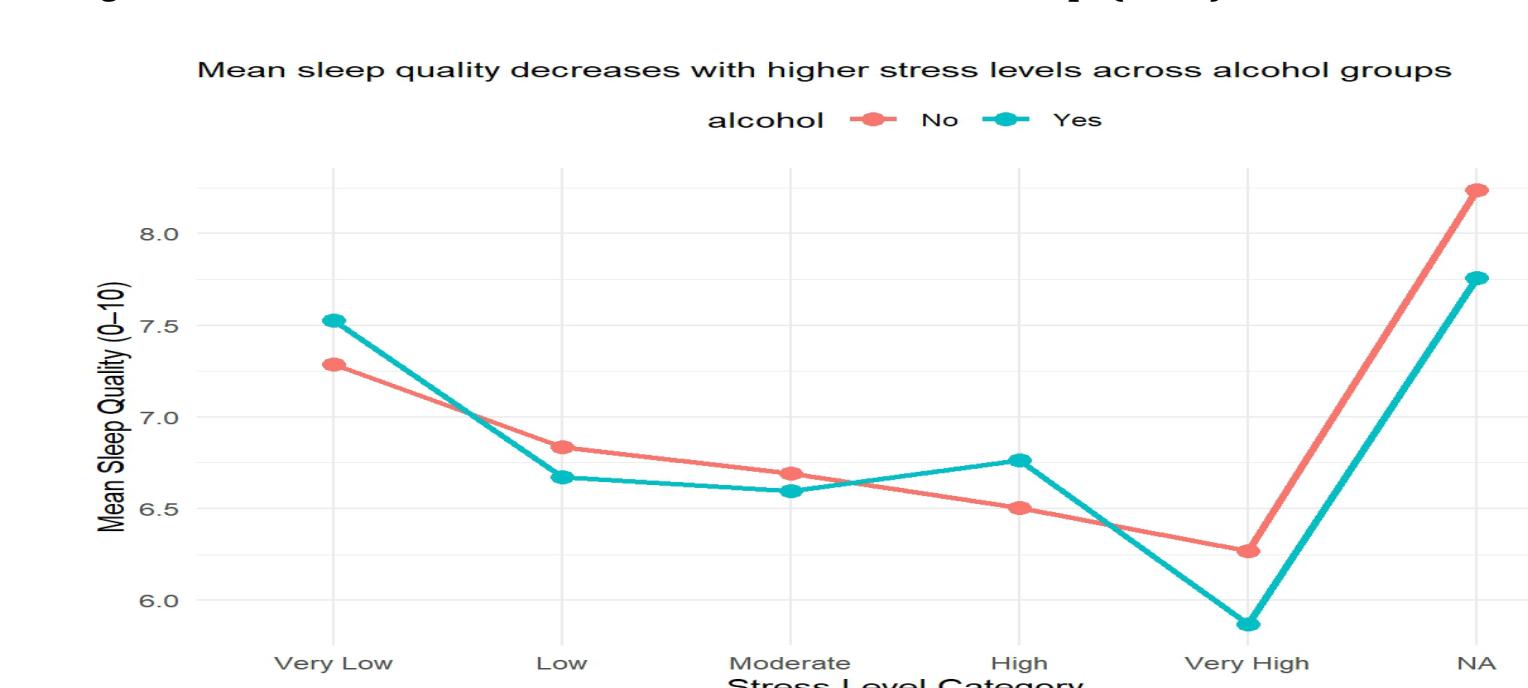
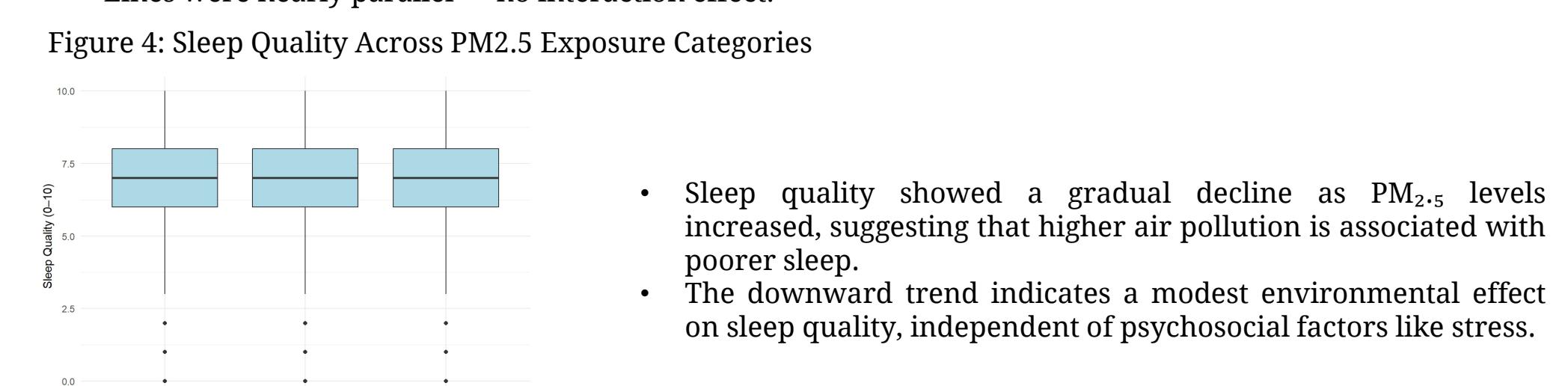


Figure 4: Sleep Quality Across PM2.5 Exposure Categories



- Sleep quality showed a gradual decline as PM<sub>2.5</sub> levels increased, suggesting that higher air pollution is associated with poorer sleep.
- The downward trend indicates a modest environmental effect on sleep quality, independent of psychosocial factors like stress.

## Regression

Table 2: Multivariable Linear Regression Model Predicting Sleep Quality  
Model: sleep\_quality ~ stress \* alcohol

| Predictor      | Estimate | p-value | Interpretation                             |
|----------------|----------|---------|--|
| stress         | -0.143   | <0.001  | Higher stress → lower sleep quality        |
| alcoholYes     | 0.099    | 0.519   | No significant difference vs. non-drinkers |
| stress*alcohol | -0.022   | 0.502   | Alcohol does NOT modify stress-sleep link  |

### Model fit:

$R^2 = 0.034 \rightarrow$  predictors explain 3.4% of variance (typical for EMA self-reported data).

Stress is the only significant predictor.

Stress significantly reduces sleep quality. ( Stress is a significant negative predictor of sleep quality)

Alcohol consumption does not significantly affect sleep, nor does it change the effect of stress.

### Environmental Exposure

PM2.5 (pm25bcn) was included as a continuous exposure variable. Continuous measurement of fine particulate matter ( $\mu\text{g}/\text{m}^3$ ).

Categorized into:

- Low PM2.5
- Medium PM2.5
- High PM2.5 (using tertiles for visualization)

### Rationale:

Air pollution is associated with sleep fragmentation, inflammation, and poorer sleep patterns.

## Key Result

### Interaction Model (Stress × Alcohol)

- Stress strongly predicts poorer sleep ( $\beta \approx -0.14$ ,  $p < 0.001$ ).
- Alcohol consumption alone is not significant ( $p > 0.5$ ).
- Stress-alcohol interaction is not significant ( $p > 0.5$ ).
- $R^2 \approx 0.034$  (modest explanatory value).

### Environmental Model with PM2.5

- PM2.5 shows a small negative association with sleep quality.
- The effect remains weaker than stress but stronger than alcohol.
- Adding PM2.5 improves the model's ecological validity.

## Discussions

- Stress is the primary determinant of sleep quality.
- Alcohol consumption does not meaningfully change the stress-sleep relationship.
- Air pollution has a modest negative impact on sleep quality.
- Combined psychosocial and environmental burdens better explain sleep variation than individual factors alone.

## Conclusion

- Stress is strongly and negatively associated with sleep quality.
- Alcohol consumption shows minimal influence on sleep in this dataset.
- Air pollution (PM2.5) is modestly associated with reduced sleep quality, suggesting an environmental burden that compounds individual stress.
- Environmental factors should be integrated into mental health and sleep research.
- Public health interventions addressing both psychosocial stress and environmental exposures may improve sleep outcomes in urban populations.

## Strengths

- High-frequency real-world data (EMA).
- Simultaneous inclusion of psychosocial and environmental variables

## Limitations

- Self-reported measures may introduce bias. (like sleep scores)
- Alcohol variable is binary (no detail on quantity or frequency).
- No control for diurnal variation in PM2.5
- Missing data reduces sample size

## Reference

CitiSHealth Barcelona Panel Study (2020–2021). CitiSHealth Project: Co-created Citizen Science for Urban Health. OpenAI. (2025). ChatGPT (Version 5.1). R code assistance for statistical analysis. <https://chat.openai.com>