# Sleep, Physical Activity, and Depressive Symptoms

Exploring wearable-derived behavioral signals and mental health

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# Motivation & Research Questions

## Why this dataset?

- Wearables offer continuous, real-world behavioral data
- Mental health is often under-measured between clinical visits

## Research Questions

- Is sleep duration associated with depressive symptom severity?
- Is physical activity (step count) associated with depressive symptoms?

# Data Overview

## Dataset Used

- GLOBEM Dataset: Multi-Year Datasets for Longitudinal Human Behavior Modeling Generalization

## Key Details

- Unit of analysis: participant-day
- Final merged dataset: ~159 observations
- Key variables:
  - Sleep duration (daily & 7-day rolling)
  - Average daily steps
  - BDI-II score

# Data Cleaning & Feature Selection

## What I did:

- Filtered to daily (:allday) and 7-day (:7dhist) summaries
- Removed:
  - Intraday features
  - Normalized (_norm) and discretized (_dis) columns
- Dropped features with >95% missingness
- Merged datasets on pid and date

```
sleep_activity_end = sleep_activity.merge(
    endterm[["pid", "date", "BDI2"]],
    on=["pid", "date"],
    how="inner"
)

sleep_activity_end.head()
```

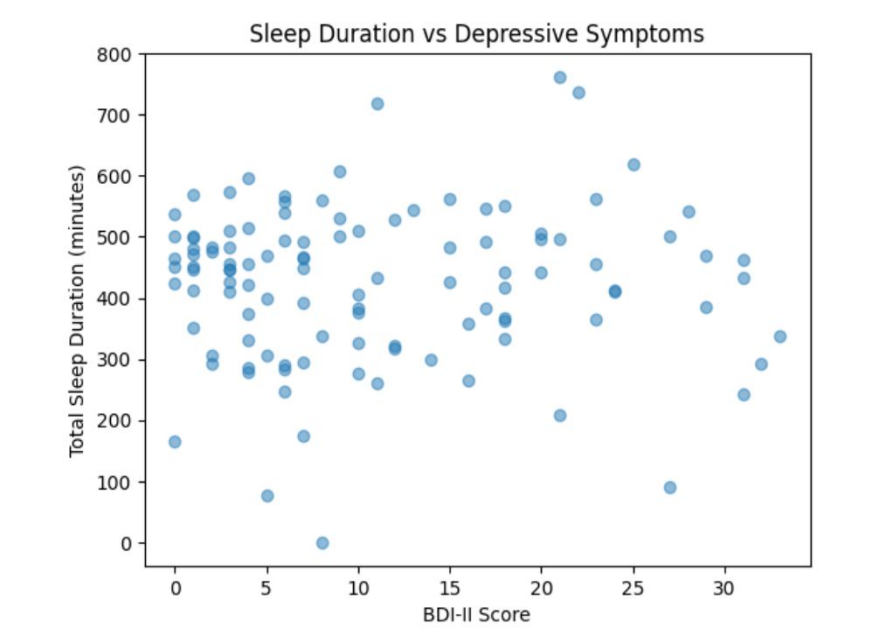
[9] ✓ 0.0s Open 'sleep_activity_end' in Data Wrangler Python

| | pid | date | f_slp:fitbit_sleep_summary_rapids_sumdurationafterwakeupmain:7dhist | f_slp:fitbit_sleep_summary_rapids_sumdurati |
|---|---|---|---|---|
| 0 | INS-W_1000 | 2021-06-16 | 2.0 | |
| 1 | INS-W_1002 | 2021-06-12 | 8.0 | |
| | | 2021- | | |

# Sleep Duration vs Depressive Symptoms

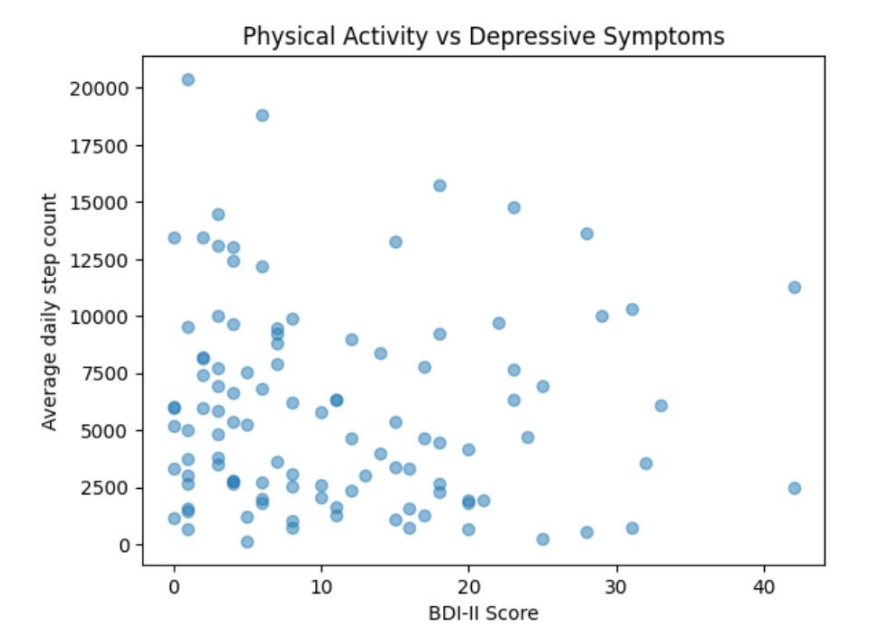
## Visualization: Scatterplot (BDI-II vs sleep duration)

- Key Observations
  - High variability in sleep across all BDI-II scores
  - No strong linear trend
  - Higher depression scores appear more frequently among shorter or irregular sleep durations
- Takeaway
  - Sleep may be weakly associated with depressive symptoms, but the relationship is noisy.



# Sleep Duration vs Depressive Symptoms

## Visualization: Scatterplot (BDI-II vs average daily steps)




Key Observations

- Wide range of activity at all depression levels
- No clear monotonic or linear relationship
- Takeaway
  - Step count alone does not appear to meaningfully distinguish depressive symptom severity.

# Regression Analysis

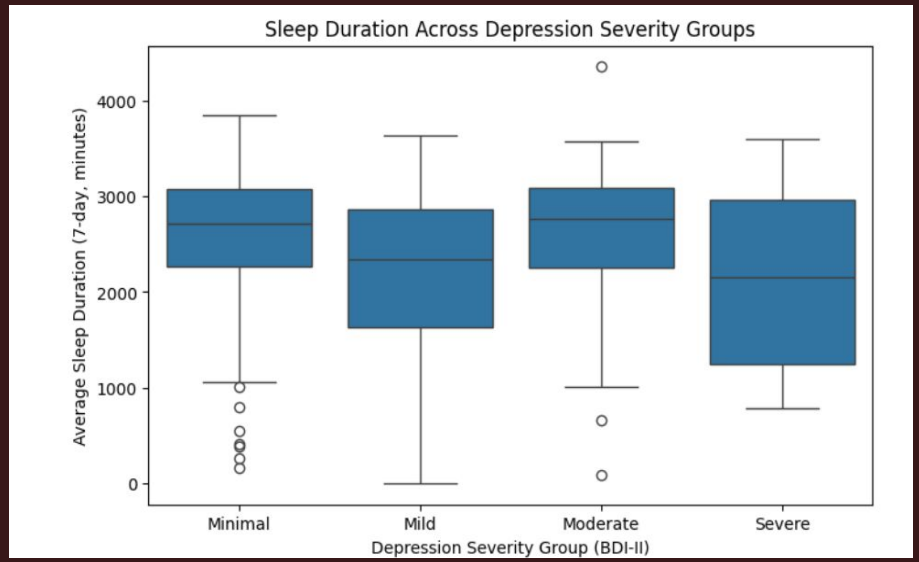
- Outcome: BDI-II score
- Predictors:
  - 7-day average sleep duration
  - 7-day average step count
- Results
  - Sleep duration: small but statistically significant negative association
  - Step count: not statistically significant
  - Low $R^2$ (~0.04)
- Interpretation
  - Sleep contributes modest explanatory power
  - Physical activity does not add much in this model.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                   BDI2   R-squared:                       0.036
Model:                            OLS   Adj. R-squared:                  0.023
Method:                 Least Squares   F-statistic:                     2.897
Date:                Fri, 30 Jan 2026   Prob (F-statistic):             0.0582
Time:                        16:58:44   Log-Likelihood:                -591.28
No. Observations:                 159   AIC:                             1189.
Df Residuals:                     156   BIC:                             1198.
Df Model:                           2
Covariance Type:            nonrobust
================================================================================================================================
                                                                   coef    std err          t      P>|t|      [0.025
--------------------------------------------------------------------------------------------------------------------------------
const                                                           18.8948      2.785      6.784      0.000      13.393
f_slp:fitbit_sleep_summary_rapids_sumdurationasleepmain:7dhist  -0.0019      0.001     -2.071      0.040      -0.004
f_steps:fitbit_steps_summary_rapids_avgsumsteps:7dhist          -0.0003      0.000     -1.167      0.245      -0.001
==============================================================================
Omnibus:                       18.327   Durbin-Watson:                   2.047
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               21.270
Skew:                           0.885   Prob(JB):                     2.41e-05
Kurtosis:                       3.282   Cond. No.                     2.48e+04
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 2.48e+04. This might indicate that there are
strong multicollinearity or other numerical problems.
```

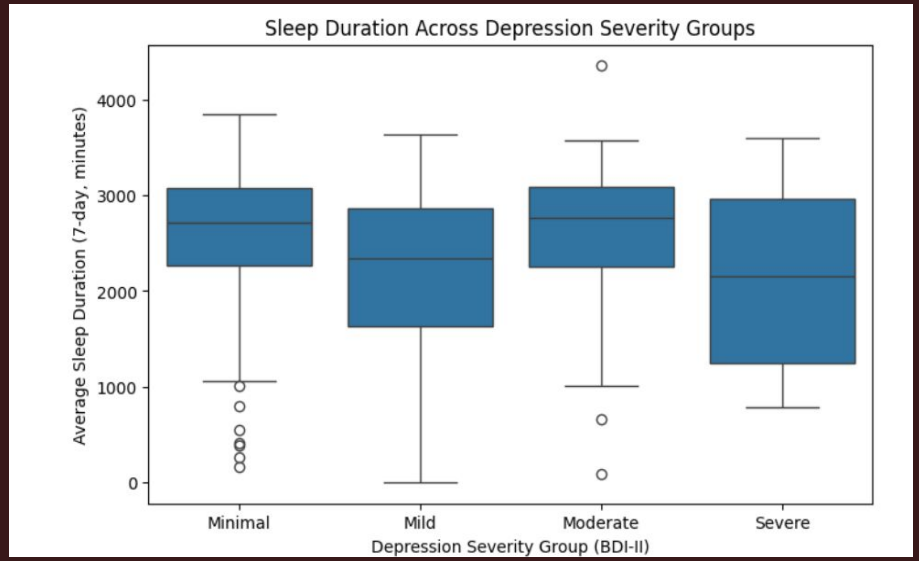
# Depression Severity Groups

- Clinical Cutoffs Used
  - Minimal: 0–13
  - Mild: 14–19
  - Moderate: 20–28
  - Severe: 29+
- Things to note:
  - Higher severity groups tend to have:
    - Lower median sleep duration
    - Greater variability in sleep
  - Substantial overlap between groups remains
- Interpretation
  - Disrupted or insufficient sleep may be associated with more severe depressive symptoms, but it is not a standalone predictor.



# Limitations & Future Work

- Limitations
  - Cross-sectional analysis
  - Missingness in wearable data
  - Control for confounders? (age, medication, etc.)
  - Wearable compliance variability
- Future Directions
  - Longitudinal modeling (within-person changes)
  - Use mixed-effects or time-series models



# Conclusion

Exploring wearable-derived behavioral signals and mental health

## Key Takeaways

- Sleep shows a modest association with depressive symptoms
- Physical activity (steps) shows little relationship
- Wearable data provides useful behavioral context but is insufficient alone in this context