



24-hour time-use behaviors and maternal depression during early pregnancy



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Background

- Subclinical depression affects ~14% in the US population and is associated with maternal and infant morbidity^{1,2}.
- Prior research associated physical activity, sedentary behavior, and sleep with depressive symptoms^{3, 4}.
- The 24 hours in a day are a fixed budget** — adding time to one behavior (e.g., physical activity) requires taking it from another (e.g., sleep or sedentary time).
- Thus, traditional regression analysis can produce bias estimates of association if they don't respect this constraint.

Objectives

- To examine the association between 24-h time-use behaviors and depressive symptoms during early pregnancy.

Methods

Study Design and Population

- Secondary analysis of the Optimizing Health From Pregnancy Through One Year Postpartum (HABIT trial)⁵.
- HABIT trial is a sequential multiple assignment randomized trial (SMART), and this study used baseline data only.
- Inclusion criteria: aged ≥18 yrs, BMI ≥25, ≤18 weeks gestation, and singleton pregnancy.
- Exclusion criteria: multiple gestations, pre-existing diabetes, bariatric surgery, or weight-affecting medications.
- This study additionally excluded participants with missingness in ActiGraph data (n = 56) and socioeconomic indicators (n=1), resulting in a total sample of 255.

24h time-use behaviors

- Wrist-worn ActiGraph** was used 24h for 7 days.
- Non-wear time ≥8h was considered invalid, and ≥1 valid day was needed for inclusion.
- The 24h day was classified into 4 components for their intensity: moderate-to-vigorous physical activity (MVPA; >77mg), light physical activity (LPA; 25-77mg), and inactivity (IA; <25mg)⁶, and sleep was detected by Heuristic algorithm⁷.

Depressive Symptom Frequency

- Self-reported using the Edinburgh Postnatal Depression Scale (EPDS)⁸; higher scores indicating frequent depressive symptoms. The range of EPDS is 0-30, with ≥9-13 suggestive of depression.
- The total scores are log-transformed for linear regression.

Statistical Analysis

- Each 24-h time-use behavior was re-expressed as **isometric log-ratio (ilr) coordinates** for linear regression.
- Linear regression** estimated how depressive symptoms (EPDS) relate to movement profiles, adjusted for maternal age, socioeconomic status (SES), and partner status.
- Latent class analysis**⁹ was used to create SES variables (low, middle, high) for education, household income, and insurance status.

Figure 1. The marginal association with EPDS scores calculated by counterfactually setting the value for each behavior by proportionally subtracting other behaviors

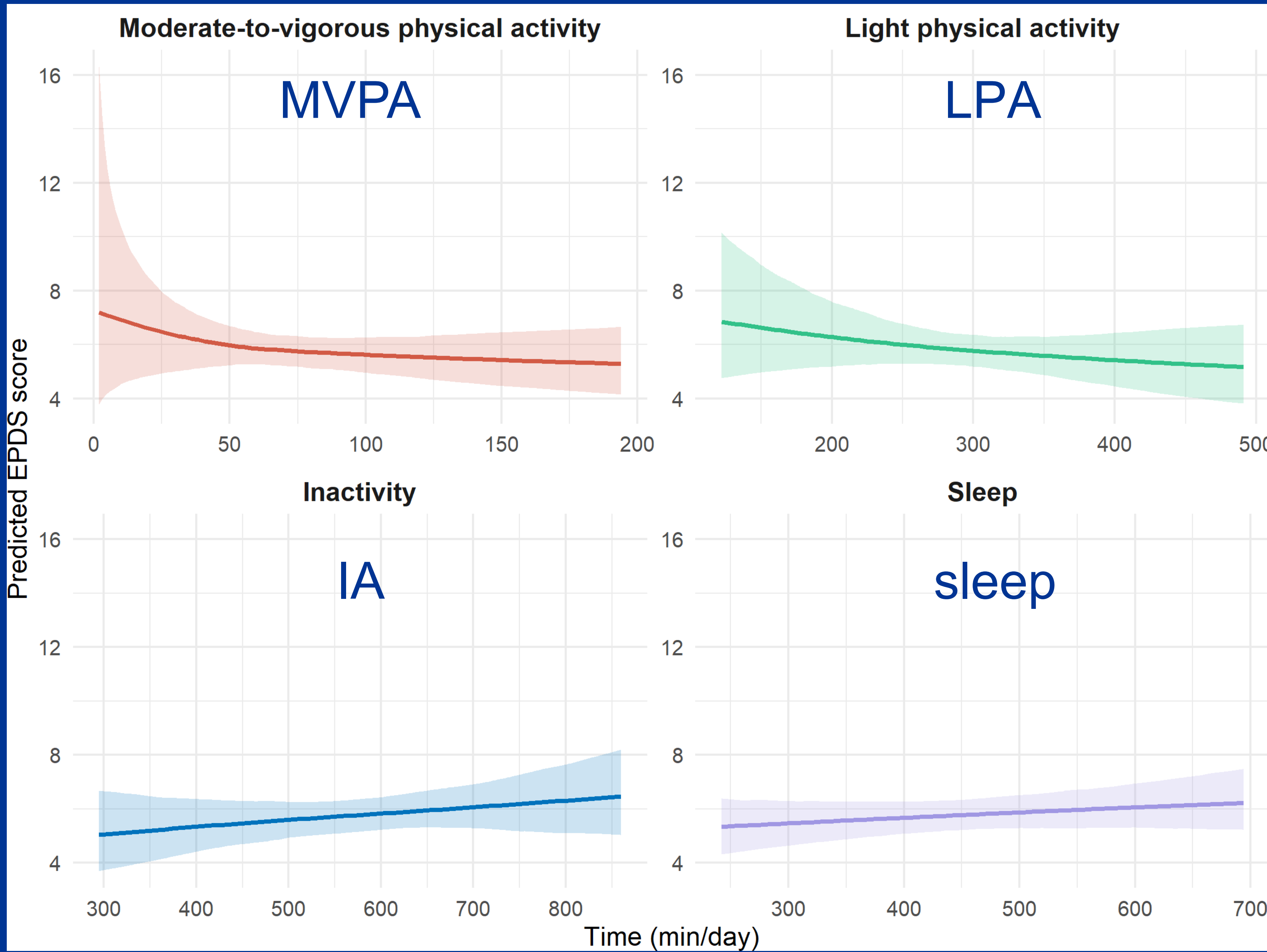
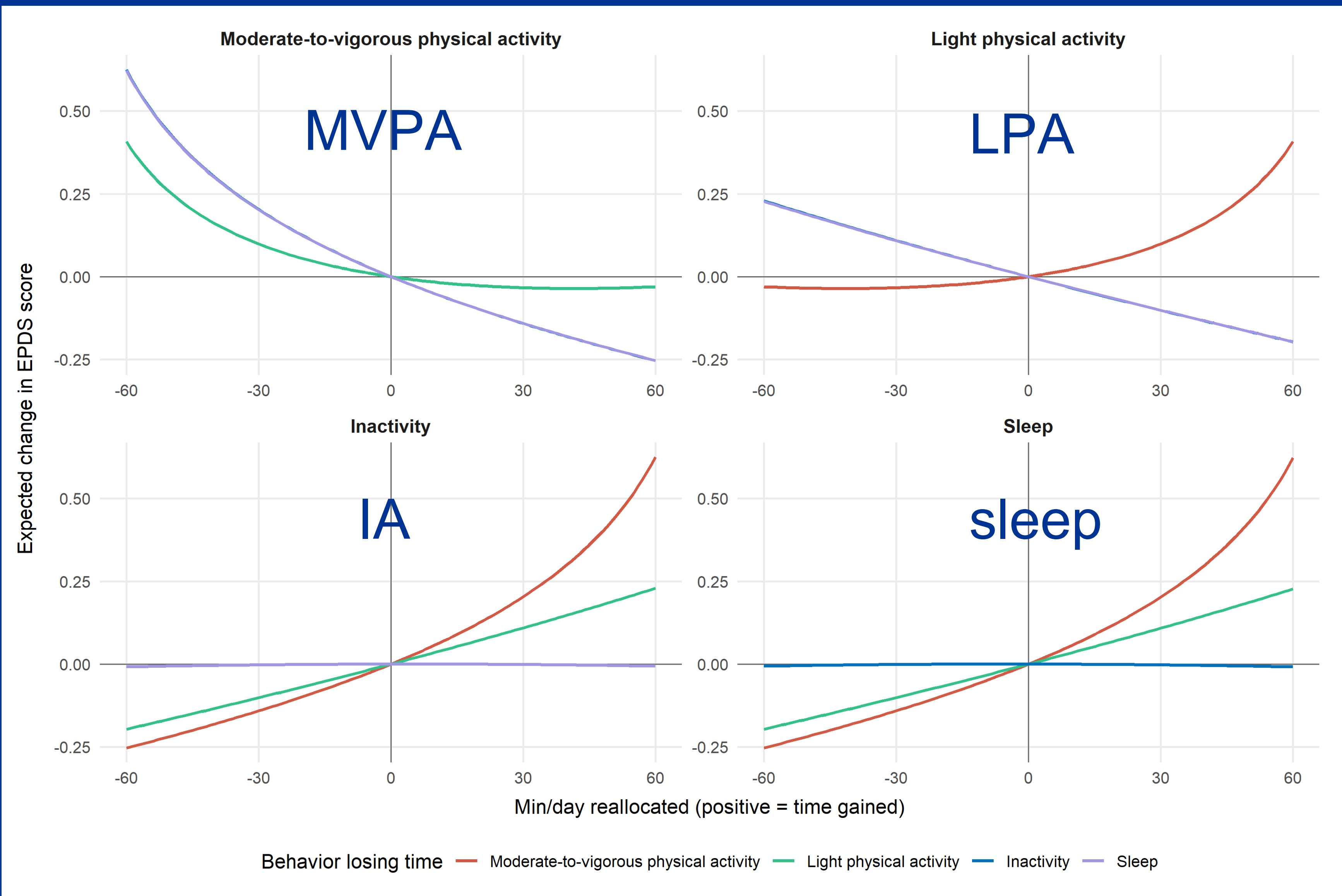


Figure 2. Reallocation effects from one behavior to another behavior (isotemporal compositional substitution model)



Statistical Analysis (cont.)

- G-computation** estimated EPDS scores when all the participants counterfactually have a certain value for each component (e.g., MVPA 30min), by proportionally reallocating from other components (e.g., LPA -5min, IA -10min, sleep -15min) while keeping the original proportions.
- Iso-temporal substitution** estimated the change in depressive symptoms if some durations were reallocated from one behavior to another (e.g., IA → LPA).

Results

Table 1. Baseline Characteristics

Characteristic	n = 255
Age (mean ±SD)	30.5±4.9
White (%)	174 (68.2%)
Low SES (%)	61 (23.9%)
Living with partner (%)	210 (82.4%)
Working (%)	196 (76.9%)
BMI, kg/m ² (median, IQR)	31.1 (28.1, 36.4)
EPDS score (median, IQR)	5.0 (2.0, 8.0)

Table 2. Compositional mean

MVPA (min/day, %)	75.5 (5.2%)
LPA (min/day, %)	311.2 (21.6%)
IA (min/day, %)	593.9 (41.2%)
Sleep (min/day, %)	459.4 (31.9%)

Key Findings & Discussion

- The contribution of 24-h time-use behaviors is not statistically significant ($F(3, 247) = 1.5$ ($p = 0.215$)).
- The baseline MVPA was much higher than the recommended duration (150 min/week).
- Although significant, higher MVPA and LPA, as well as lower IA and sleep, are associated with fewer depressive symptoms.
- Reverse causation** was not ruled out: depressive symptoms could cause longer sleep duration rather than the reverse. Longitudinal study is needed.
- Future studies benefit from rigorous measures (e.g., sleep log and a combination of ActiGraph and ActivPAL).

Conclusions

- In this relatively active individuals in early pregnancy, 24-h behaviors were not associated with depressive symptoms.
- Future research should also focus on later in pregnancy or postpartum period.

