Multiverse analysis

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Abstract

One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

*Keywords:* keywords

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Multiverse analysis

# Results

## Model diagnostics

The model diagnostics for the main analysis, and for all models presented in this document are in Table 1

Table 1:

*Model diagnostics*

| Model name | Skewness | Kurtosis | Converged (%) |
| --- | --- | --- | --- |
| Models moderated by age |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.39 | 100.00% |
| Scale sleep efficiency by PA volume | -0.93 | -3.79 | 100.00% |
| Scale sleep onset by PA volume | 0.47 | -4.84 | 100.00% |
| Scale sleep regularity by PA volume | -0.86 | -3.20 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.37 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.93 | -3.77 | 100.00% |
| Scale sleep onset by PA intensity | 0.47 | -4.75 | 100.00% |
| Scale sleep regularity by PA intensity | -0.85 | -3.16 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.14 | -12.71 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.74 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.14 | -12.78 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.14 | -12.71 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.18 | -13.08 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.18 | -2.67 | 100.00% |
| Models moderated by bmi |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.40 | 100.00% |
| Scale sleep efficiency by PA volume | -0.93 | -3.79 | 100.00% |
| Scale sleep onset by PA volume | 0.47 | -4.83 | 100.00% |
| Scale sleep regularity by PA volume | -0.86 | -3.22 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.37 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.93 | -3.77 | 100.00% |
| Scale sleep onset by PA intensity | 0.47 | -4.75 | 100.00% |
| Scale sleep regularity by PA intensity | -0.86 | -3.13 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.14 | -12.72 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.75 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.14 | -12.78 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.14 | -12.73 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.18 | -13.06 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.17 | -2.67 | 100.00% |
| Models moderated by ses |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.40 | 100.00% |
| Scale sleep efficiency by PA volume | -0.93 | -3.78 | 100.00% |
| Scale sleep onset by PA volume | 0.46 | -4.84 | 100.00% |
| Scale sleep regularity by PA volume | -0.86 | -3.19 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.37 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.93 | -3.77 | 100.00% |
| Scale sleep onset by PA intensity | 0.47 | -4.76 | 100.00% |
| Scale sleep regularity by PA intensity | -0.86 | -3.11 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.14 | -12.71 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.75 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.14 | -12.78 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.14 | -12.72 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.18 | -13.06 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.17 | -2.68 | 100.00% |
| Models moderated by sex |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.40 | 100.00% |
| Scale sleep efficiency by PA volume | -0.93 | -3.77 | 100.00% |
| Scale sleep onset by PA volume | 0.47 | -4.82 | 100.00% |
| Scale sleep regularity by PA volume | -0.86 | -3.19 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.37 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.93 | -3.78 | 100.00% |
| Scale sleep onset by PA intensity | 0.47 | -4.75 | 100.00% |
| Scale sleep regularity by PA intensity | -0.86 | -3.12 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.14 | -12.73 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.75 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.14 | -12.76 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.14 | -12.71 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.18 | -13.08 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.17 | -2.67 | 100.00% |
| Models moderated by weekday |  |  |  |
| Scale sleep duration by PA volume | 0.07 | -2.35 | 100.00% |
| Scale sleep efficiency by PA volume | -0.92 | -3.79 | 100.00% |
| Scale sleep onset by PA volume | 0.45 | -4.92 | 100.00% |
| Scale sleep regularity by PA volume | -0.91 | -3.59 | 100.00% |
| Scale sleep duration by PA intensity | 0.07 | -2.35 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.91 | -3.76 | 100.00% |
| Scale sleep onset by PA intensity | 0.46 | -4.80 | 100.00% |
| Scale sleep regularity by PA intensity | -0.92 | -3.62 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.20 | -13.14 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.19 | -2.84 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.19 | -13.22 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.19 | -2.88 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.20 | -13.19 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.20 | -2.89 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.22 | -13.34 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.21 | -2.76 | 100.00% |
| Models moderated by season |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.38 | 100.00% |
| Scale sleep efficiency by PA volume | -0.92 | -3.77 | 100.00% |
| Scale sleep onset by PA volume | 0.47 | -4.82 | 100.00% |
| Scale sleep regularity by PA volume | -0.86 | -3.23 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.36 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.93 | -3.77 | 100.00% |
| Scale sleep onset by PA intensity | 0.47 | -4.76 | 100.00% |
| Scale sleep regularity by PA intensity | -0.86 | -3.11 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.14 | -12.67 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.76 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.14 | -12.79 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.14 | -12.67 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.14 | -2.74 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.18 | -13.09 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.17 | -2.68 | 100.00% |
| Models moderated by region |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.41 | 100.00% |
| Scale sleep efficiency by PA volume | -0.92 | -3.81 | 100.00% |
| Scale sleep onset by PA volume | 0.46 | -4.82 | 100.00% |
| Scale sleep regularity by PA volume | -0.86 | -3.22 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.36 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.92 | -3.76 | 100.00% |
| Scale sleep onset by PA intensity | 0.46 | -4.73 | 100.00% |
| Scale sleep regularity by PA intensity | -0.84 | -3.07 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.15 | -12.72 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.77 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.14 | -12.73 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.74 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.14 | -12.74 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.13 | -2.74 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.19 | -13.08 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.17 | -2.67 | 100.00% |
| Models moderated by daylight |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.41 | 100.00% |
| Scale sleep efficiency by PA volume | -0.93 | -3.79 | 100.00% |
| Scale sleep onset by PA volume | 0.47 | -4.83 | 100.00% |
| Scale sleep regularity by PA volume | -0.86 | -3.21 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.38 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.93 | -3.78 | 100.00% |
| Scale sleep onset by PA intensity | 0.47 | -4.75 | 100.00% |
| Scale sleep regularity by PA intensity | -0.86 | -3.12 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.14 | -12.72 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.76 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.14 | -12.78 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.14 | -12.73 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.14 | -2.74 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.18 | -13.07 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.18 | -2.66 | 100.00% |
| Models moderated by wear location |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.40 | 100.00% |
| Scale sleep efficiency by PA volume | -0.92 | -3.82 | 100.00% |
| Scale sleep onset by PA volume | 0.47 | -4.85 | 100.00% |
| Scale sleep regularity by PA volume | -0.86 | -3.21 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.37 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.92 | -3.76 | 100.00% |
| Scale sleep onset by PA intensity | 0.48 | -4.73 | 100.00% |
| Scale sleep regularity by PA intensity | -0.85 | -3.14 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.14 | -12.71 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.75 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.14 | -12.78 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.14 | -12.75 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.18 | -13.07 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.19 | -2.67 | 100.00% |
| Models moderated by PA mostactivehr |  |  |  |
| Scale sleep duration by PA volume | 0.09 | -2.40 | 100.00% |
| Scale sleep efficiency by PA volume | -0.93 | -3.79 | 100.00% |
| Scale sleep onset by PA volume | 0.47 | -4.83 | 100.00% |
| Scale sleep regularity by PA volume | -0.85 | -3.16 | 100.00% |
| Scale sleep duration by PA intensity | 0.09 | -2.37 | 100.00% |
| Scale sleep efficiency by PA intensity | -0.93 | -3.78 | 100.00% |
| Scale sleep onset by PA intensity | 0.47 | -4.74 | 100.00% |
| Scale sleep regularity by PA intensity | -0.85 | -3.06 | 100.00% |
| Scale PA volume by sleep duration(lagged) | 1.14 | -12.61 | 100.00% |
| Scale PA intensity by sleep duration(lagged) | 0.14 | -2.75 | 100.00% |
| Scale PA volume by sleep efficiency(lagged) | 1.13 | -12.70 | 100.00% |
| Scale PA intensity by sleep efficiency(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep onset(lagged) | 1.13 | -12.63 | 100.00% |
| Scale PA intensity by sleep onset(lagged) | 0.14 | -2.73 | 100.00% |
| Scale PA volume by sleep regularity(lagged) | 1.17 | -12.93 | 100.00% |
| Scale PA intensity by sleep regularity(lagged) | 0.17 | -2.66 | 100.00% |

## Multiverse

In this document we show the relationship between sleep and physical activity by the moderators that were pre-registered in our protocol.

# Moderation

In the following section we present models for a range of moderators which were pre-defined in our protocol.