

## Multiverse analysis

First Author<sup>1</sup> & Ernst-August Doelle<sup>1,2</sup>

<sup>1</sup> Wilhelm-Wundt-University

<sup>2</sup> Konstanz Business School

## Author Note

Add complete departmental affiliations for each author here. Each new line herein must be indented, like this line.

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The authors made the following contributions. First Author: Conceptualization, Writing - Original Draft Preparation, Writing - Review & Editing; Ernst-August Doelle: Writing - Review & Editing, Supervision.

Correspondence concerning this article should be addressed to First Author, Postal address. E-mail: my@email.com

## Abstract

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

*Keywords:* keywords

Word count: X

## Multiverse analysis

### Results

#### Multiverse

In this document we show the results using another analytic technique. Namely treating study ID as a fixed effect. This is what we wrote in the protocol originally.

#### The effects of physical activity volume on sleep

We estimated the effects of physical activity on sleep (RQ1) using mixed-effects models. We estimated the effect of physical activity volume on sleep by age, and the results are presented in Table 1 and Figure 1.

#### The effects of physical activity intensity on sleep

We estimated how physical activity intensity affects sleep across different age groups. We present the results controlling for sex, SES, and BMI, in Table 1 and Figure 2.

#### The effects of sleep duration on physical activity

We estimated the effect of sleep duration on physical activity by age. Results, controlling for sex, SES, and BMI are presented in Table 2 and Figure 3.

#### The effects of sleep efficiency on physical activity

We estimated the effect of sleep efficiency on physical activity by age. Results, controlling for sex, SES, and BMI are presented in Table 2 and Figure 4.

**The effects of sleep onset on physical activity**

We estimated the effect of sleep onset on physical activity by age. Results, controlling for sex, SES, and BMI are presented in Table 2 and Figure 5.

**The effects of sleep regularity on physical activity**

We estimated the effect of sleep regularity on physical activity by age. Results, controlling for sex, SES, and BMI are presented in Table 2 and Figure 6.

Table 1

*Physical activity on sleep controlling for SES, gender and BMI*

Term	Physical Activity Volume			Physical Activity Intensity		
	$\beta$ [95% CI]	SE	t	$\beta$ [95% CI]	SE	t
Sleep duration						
(Intercept)	0.51 [-0.42, 1.43]	0.47	1.07	0.57 [-0.24, 1.39]	0.42	1.38
Physical activity	-0.10 [-0.60, 0.41]	0.26	-0.37	0.09 [-0.78, 0.95]	0.44	0.19
Age	0.00 [-0.01, 0.00]	0.00	-1.07	0.00 [-0.01, 0.00]	0.00	-1.17
Physical activity <sup>2</sup>	0.01 [-0.05, 0.06]	0.03	0.26	-0.03 [-0.23, 0.16]	0.10	-0.33
Physical activity $\times$ age	0.00 [0.00, 0.01]	0.00	0.49	0.00 [-0.01, 0.01]	0.01	-0.21
Age $\times$ Physical activity <sup>2</sup>	0.00 [0.00, 0.00]	0.00	-0.36	0.00 [0.00, 0.00]	0.00	0.26
Sleep efficiency						
(Intercept)	-0.36 [-1.05, 0.34]	0.35	-1.01	-0.44 [-1.09, 0.21]	0.33	-1.33
Physical activity	0.08 [-0.34, 0.49]	0.21	0.35	0.05 [-0.54, 0.64]	0.30	0.17
Age	0.00 [-0.01, 0.01]	0.00	0.15	0.00 [0.00, 0.01]	0.00	0.52
Physical activity <sup>2</sup>	-0.01 [-0.06, 0.03]	0.02	-0.59	0.00 [-0.17, 0.18]	0.09	0.03
Physical activity $\times$ age	0.00 [-0.01, 0.00]	0.00	-0.76	0.00 [-0.01, 0.01]	0.00	-0.23
Age $\times$ Physical activity <sup>2</sup>	0.00 [0.00, 0.00]	0.00	0.84	0.00 [0.00, 0.00]	0.00	-0.23
Sleep onset						
(Intercept)	-0.82 [-1.37, -0.26]	0.28	-2.88	-0.81 [-1.39, -0.23]	0.30	-2.72
Physical activity	0.29 [-0.24, 0.83]	0.27	1.09	-0.30 [-0.88, 0.28]	0.29	-1.02
Age	0.00 [0.00, 0.01]	0.00	0.88	0.00 [0.00, 0.00]	0.00	0.10
Physical activity <sup>2</sup>	-0.04 [-0.12, 0.04]	0.04	-1.02	0.06 [-0.07, 0.19]	0.07	0.90
Physical activity $\times$ age	-0.01 [-0.01, 0.00]	0.00	-1.25	0.00 [-0.01, 0.01]	0.00	0.79
Age $\times$ Physical activity <sup>2</sup>	0.00 [0.00, 0.00]	0.00	1.03	0.00 [0.00, 0.00]	0.00	-0.90
Sleep regularity						
(Intercept)	0.32 [-0.01, 0.64]	0.17	1.88	0.25 [-0.16, 0.67]	0.21	1.20
Physical activity	0.24 [0.02, 0.45]	0.11	2.17	0.05 [-0.46, 0.56]	0.26	0.19

Table 1 continued

Term	Physical Activity Volume			Physical Activity Intensity		
	$\beta$ [95% CI]	SE	t	$\beta$ [95% CI]	SE	t
Age	0.00 [0.00, 0.01]	0.00	0.56	0.00 [0.00, 0.00]	0.00	-0.33
Physical activity <sup>2</sup>	-0.03 [-0.07, 0.02]	0.02	-1.15	0.01 [-0.16, 0.19]	0.09	0.15
Physical activity $\times$ age	0.00 [0.00, 0.00]	0.00	-0.50	0.00 [-0.01, 0.01]	0.00	-0.15
Age $\times$ Physical activity <sup>2</sup>	0.00 [0.00, 0.00]	0.00	-1.45	0.00 [0.00, 0.00]	0.00	-0.41

*Note.* Adjusted for SES, BMI, and sex.

Table 2

*Sleep on physical activity controlling for SES, gender and BMI*

Term	Physical Activity Volume			Physical Activity Intensity				
	$\beta$ [95% CI]	SE	t	p	$\beta$ [95% CI]	SE	t	p
Sleep duration								
(Intercept)	0.23 [-0.15, 0.62]	0.20	1.20	.282	0.71 [0.10, 1.31]	0.31	2.30	.112
Sleep duration	-0.03 [-0.09, 0.03]	0.03	-0.99	.394	0.04 [-0.08, 0.16]	0.06	0.58	.616
Age	-0.01 [-0.02, -0.01]	0.00	-5.39	.002	-0.02 [-0.02, -0.01]	0.00	-6.08	.004
Sleep duration <sup>2</sup>	0.03 [-0.01, 0.07]	0.02	1.49	.252	-0.02 [-0.11, 0.07]	0.05	-0.50	.669
Sleep duration $\times$ age	0.00 [0.00, 0.00]	0.00	0.06	.957	0.00 [0.00, 0.00]	0.00	-0.34	.766
Age $\times$ Sleep duration <sup>2</sup>	0.00 [0.00, 0.00]	0.00	-2.32	.094	0.00 [0.00, 0.00]	0.00	0.11	.921
Sleep efficiency								
(Intercept)	0.25 [-0.12, 0.63]	0.19	1.32	.239	0.68 [0.00, 1.37]	0.35	1.96	.159
Sleep efficiency	0.01 [-0.03, 0.05]	0.02	0.36	.726	-0.03 [-0.11, 0.06]	0.05	-0.58	.612
Age	-0.02 [-0.02, -0.01]	0.00	-5.70	.002	-0.02 [-0.02, -0.01]	0.00	-6.81	.001
Sleep efficiency <sup>2</sup>	0.01 [-0.01, 0.02]	0.01	0.91	.388	-0.01 [-0.04, 0.03]	0.02	-0.45	.692
Sleep efficiency $\times$ age	0.00 [0.00, 0.00]	0.00	0.14	.893	0.00 [0.00, 0.00]	0.00	0.71	.536
Age $\times$ Sleep efficiency <sup>2</sup>	0.00 [0.00, 0.00]	0.00	0.11	.917	0.00 [0.00, 0.00]	0.00	0.54	.630
Sleep onset								
(Intercept)	0.27 [-0.13, 0.66]	0.20	1.33	.239	0.71 [0.05, 1.37]	0.34	2.11	.136
Sleep onset	-0.01 [-0.10, 0.07]	0.04	-0.31	.784	-0.01 [-0.06, 0.04]	0.02	-0.31	.774
Age	-0.02 [-0.02, -0.01]	0.00	-5.55	.002	-0.02 [-0.02, -0.01]	0.00	-6.72	.001
Sleep onset <sup>2</sup>	-0.01 [-0.04, 0.02]	0.01	-0.73	.482	-0.02 [-0.07, 0.03]	0.02	-0.88	.451
Sleep onset $\times$ age	0.00 [0.00, 0.00]	0.00	0.23	.838	0.00 [0.00, 0.00]	0.00	0.39	.722
Age $\times$ Sleep onset <sup>2</sup>	0.00 [0.00, 0.00]	0.00	-0.06	.949	0.00 [0.00, 0.00]	0.00	0.91	.412
Sleep regularity								
(Intercept)	0.25 [-0.13, 0.63]	0.19	1.28	.253	0.71 [0.06, 1.36]	0.33	2.13	.135
Sleep regularity	0.08 [0.00, 0.17]	0.04	1.99	.160	0.10 [0.05, 0.14]	0.02	4.19	.018

Table 2 continued

Term	Physical Activity Volume				Physical Activity Intensity					
	$\beta$	[95% CI]	SE	t	p	$\beta$	[95% CI]	SE	t	p
Age	-0.02	[-0.02, -0.01]	0.00	-5.07	.006	-0.02	[-0.02, -0.01]	0.00	-6.40	.002
Sleep regularity <sup>2</sup>	0.01	[-0.03, 0.04]	0.02	0.29	.791	-0.01	[-0.04, 0.01]	0.01	-1.00	.379
Sleep regularity $\times$ age	0.00	[0.00, 0.00]	0.00	-0.88	.413	0.00	[0.00, 0.00]	0.00	-3.68	.003
Age $\times$ Sleep regularity <sup>2</sup>	0.00	[0.00, 0.00]	0.00	-0.09	.933	0.00	[0.00, 0.00]	0.00	1.34	.196

*Note.* Adjusted for SES, BMI, and sex.



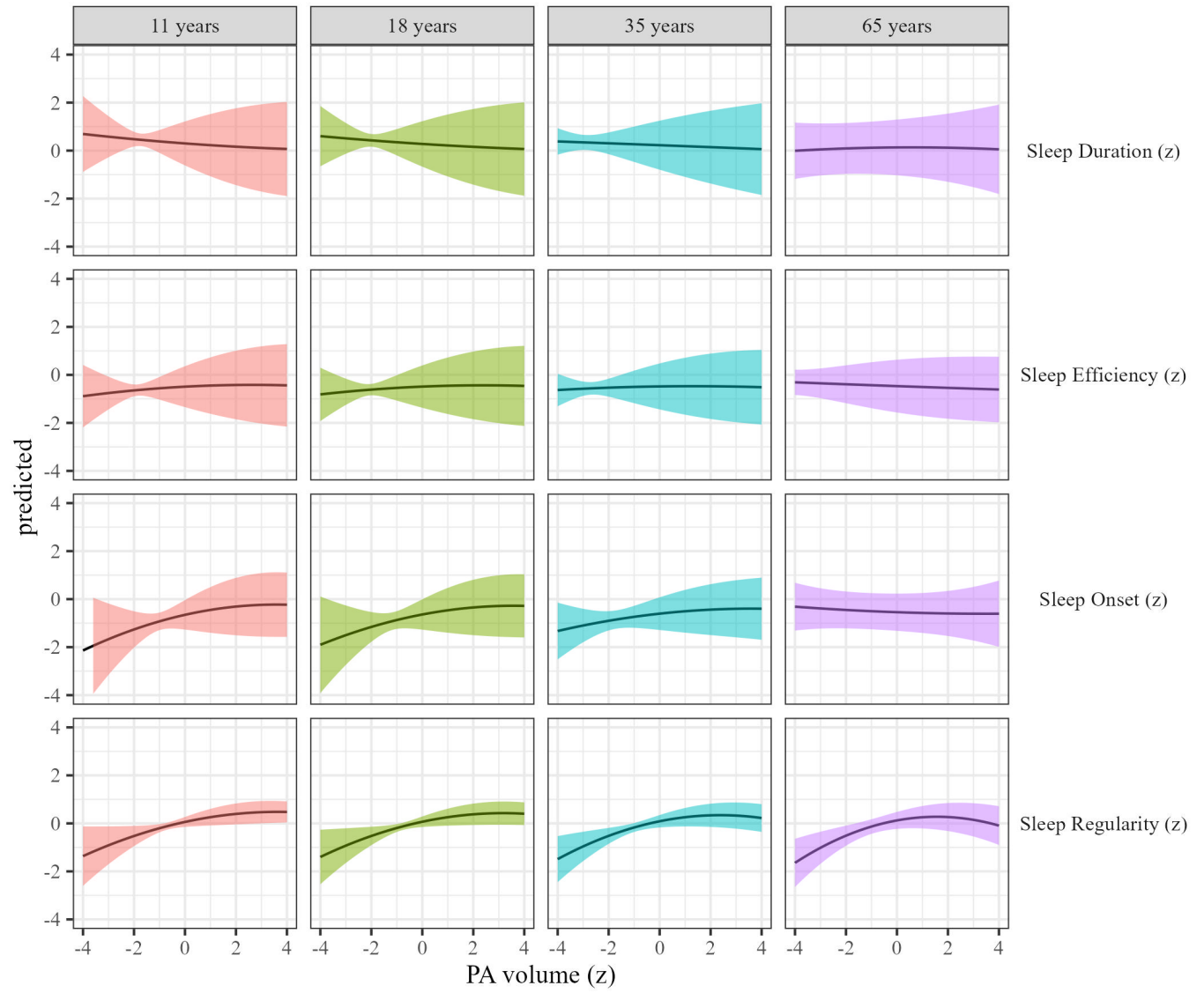


Figure 1. Sleep metrics on Physical activity volume

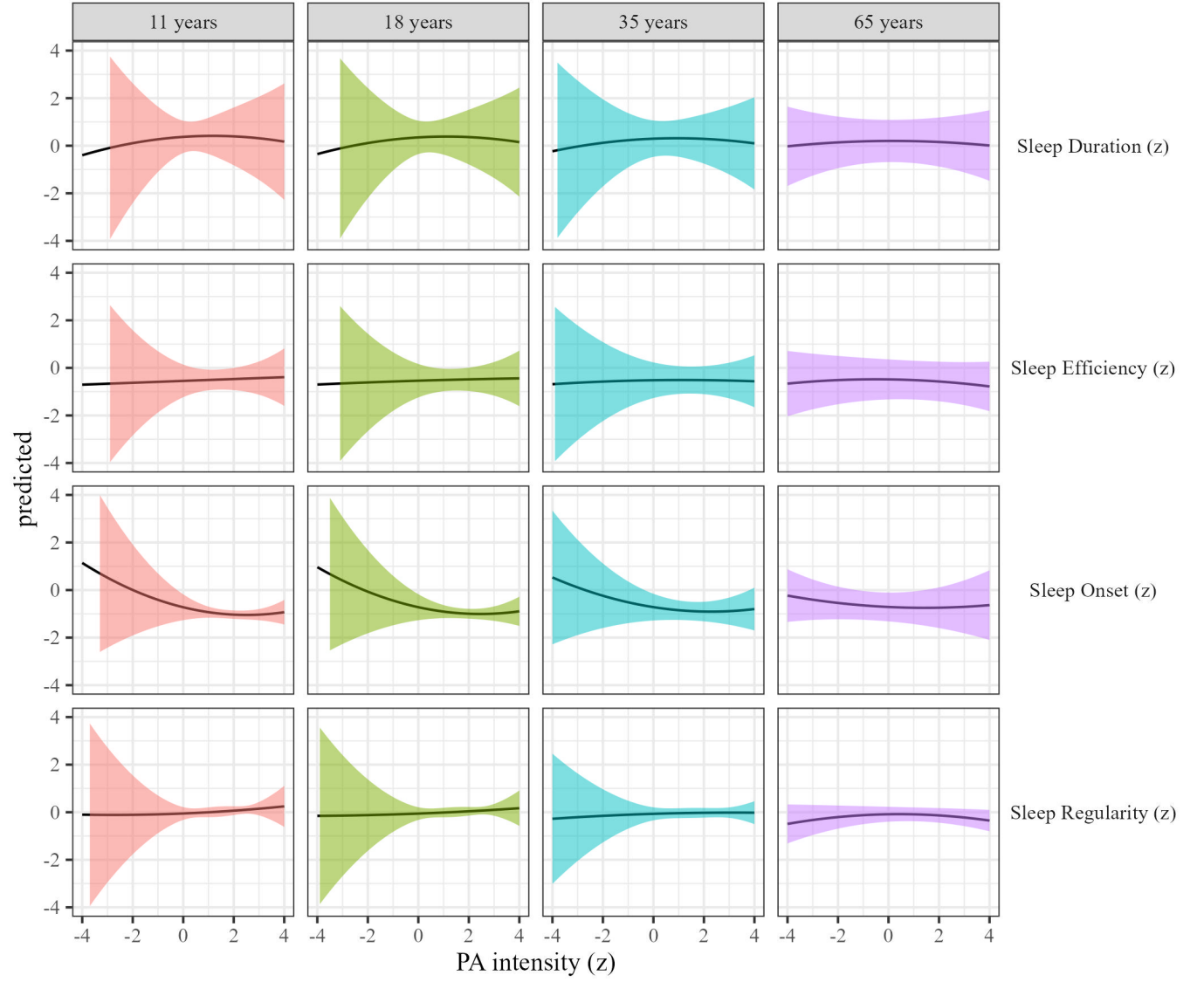


Figure 2. Sleep metrics on Physical activity intensity

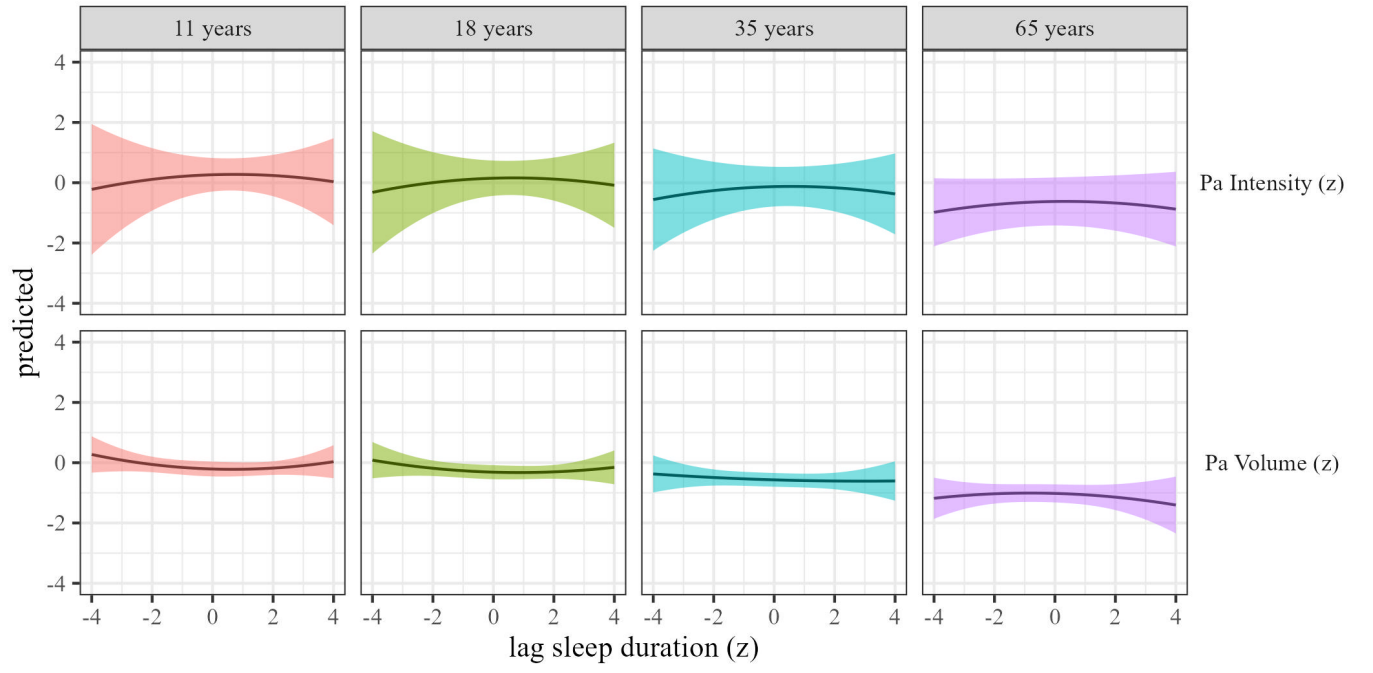


Figure 3. Physical activity by sleep duration

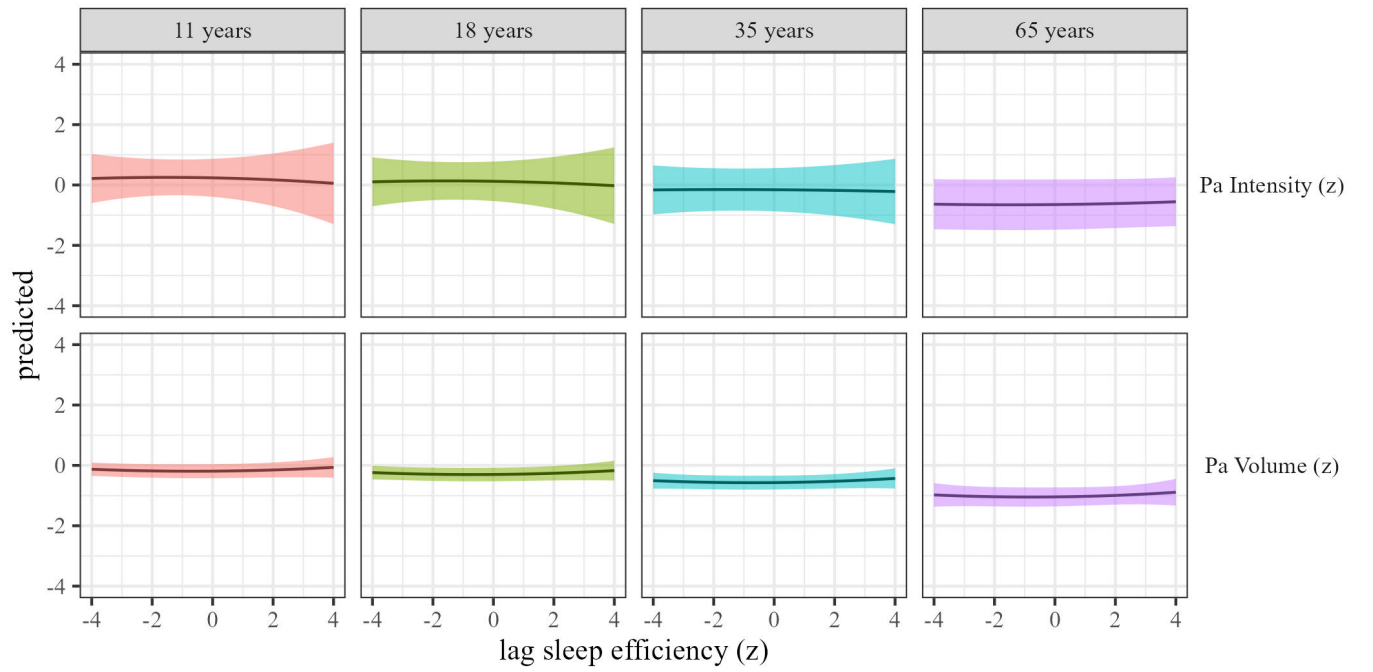


Figure 4. Physical activity by sleep efficiency

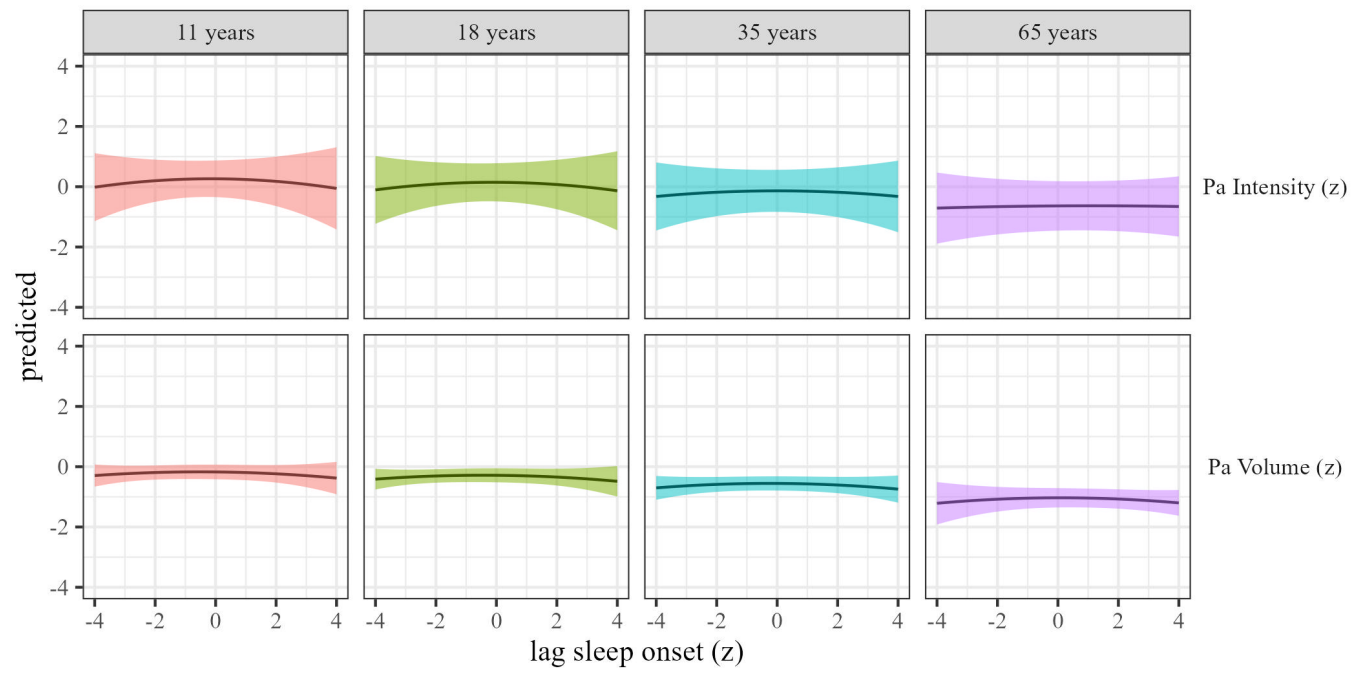


Figure 5. Physical activity by sleep onset

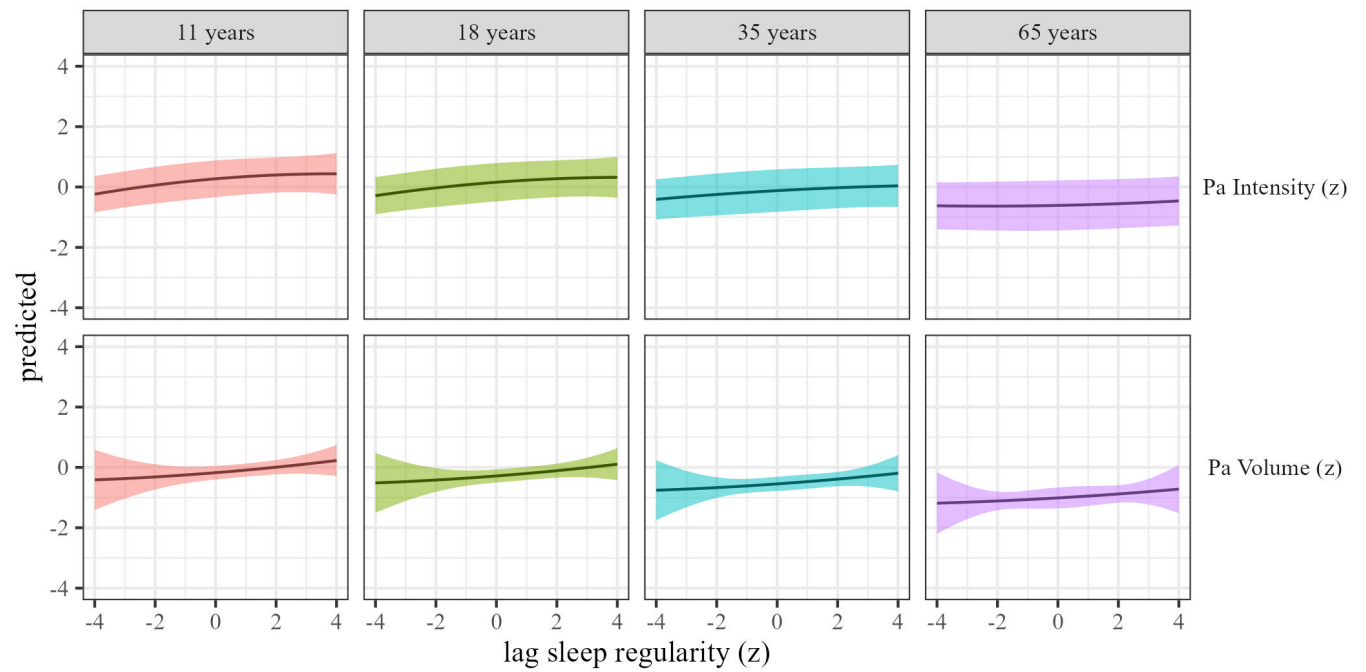


Figure 6. Physical activity by sleep regularity