

The mediation and moderation role of sleep in the association between physical activity and cognition in the elderly population

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INTRODUCTION

- Physical activity (PA) is found to have benefits for aging by improving cognitive functioning and protecting older adults against dementia.^{1,2}
- Accumulating evidence suggests that sleep problems can have negative effects on cognitive functioning in older adults.^{3,4}
- Higher PA might lead to better sleep quality and fewer sleep problems. However, very few studies have examined this.
- Purpose:** To investigate whether sleep mediates or moderates the relationship between PA and cognition in older adults.

METHOD

Study design: Cross-sectional

Study subjects: A total of 2594 participants from the Washington Heights - Inwood Community Aging Project (WHICAP)

Exposures: PA and sleep were self-reported using standard questionnaires.

- The metabolic equivalent of PA energy expenditure was calculated
- Based on a 12-question MOS questionnaire, a sleep problem index was calculated, reflecting sleep disturbance, adequacy, and somnolence. A higher value for the index indicates worse sleep.

Cognition outcome: Assessed by an extensive neuropsychological battery. Performance was summarized into 4 domain-specific z-scores: memory, language, processing speed, and visual spatial ability.

Statistical methods: Linear regression models were used to examine the relationships between PA, sleep, and cognition. Moderation effect was tested by including an interaction term of PA and sleep into the model. Mediation was assessed by examining whether there was a change (>15%) in the association when sleep index was introduced into the model.

RESULTS

Table 1. Characteristics of study population

	All (n = 2594)	No Exercise (n = 815)	Some Exercise (n = 961)	Much Exercise (n = 818)	P-value
Female	1790 (69%)	607 (74.5%)	659 (68.6%)	524 (64.1%)	< 0.0001
Age	75.60 ± 6.44	77.20 ± 6.91	75.80 ± 6.29	73.70 ± 5.58	< 0.0001
Education (years)	11.70 ± 5.10	10.20 ± 5.10	11.70 ± 4.93	13.30 ± 4.84	< 0.0001
Comorbidity score	3.08 ± 1.60	3.38 ± 1.62	3.08 ± 1.57	2.78 ± 1.57	< 0.0001
Sleep Index Score	19.40 ± 15.50	22.50 ± 16.40	19.30 ± 15.20	16.40 ± 14.10	< 0.0001
Language	0.361 ± 0.664	0.108 ± 0.664	0.400 ± 0.640	0.568 ± 0.608	< 0.0001
Memory	0.343 ± 0.712	0.191 ± 0.708	0.320 ± 0.683	0.520 ± 0.711	< 0.0001
Executive speed	0.343 ± 1.020	0.038 ± 1.080	0.310 ± 1.020	0.637 ± 0.870	< 0.0001
Visuospatial	0.352 ± 0.604	0.130 ± 0.668	0.378 ± 0.555	0.538 ± 0.519	< 0.0001

Table 2. Association between PA and cognition

PA	Model 1				Model 2			
	Language	Memory	Speed	Visual	Language	Memory	Speed	Visual
None	0 Reference	0 Reference	0 Reference	0 Reference	0 Reference	0 Reference	0 Reference	0 Reference
Some	0.291 (0.231, 0.351)	0.129 (0.063, 0.195)	0.272 (0.170, 0.373)	0.248 (0.193, 0.303)	0.138 (0.093, 0.184)	0.014 (-0.045, 0.073)	0.102 (0.017, 0.187)	0.117 (0.072, 0.161)
Much	0.459 (0.397, 0.521)	0.329 (0.261, 0.400)	0.598 (0.495, 0.702)	0.408 (0.351, 0.465)	0.153 (0.104, 0.203)	0.088 (0.024, 0.152)	0.188 (0.098, 0.278)	0.139 (0.090, 0.187)

Figure 1. Beta coefficients for association between PA and cognition

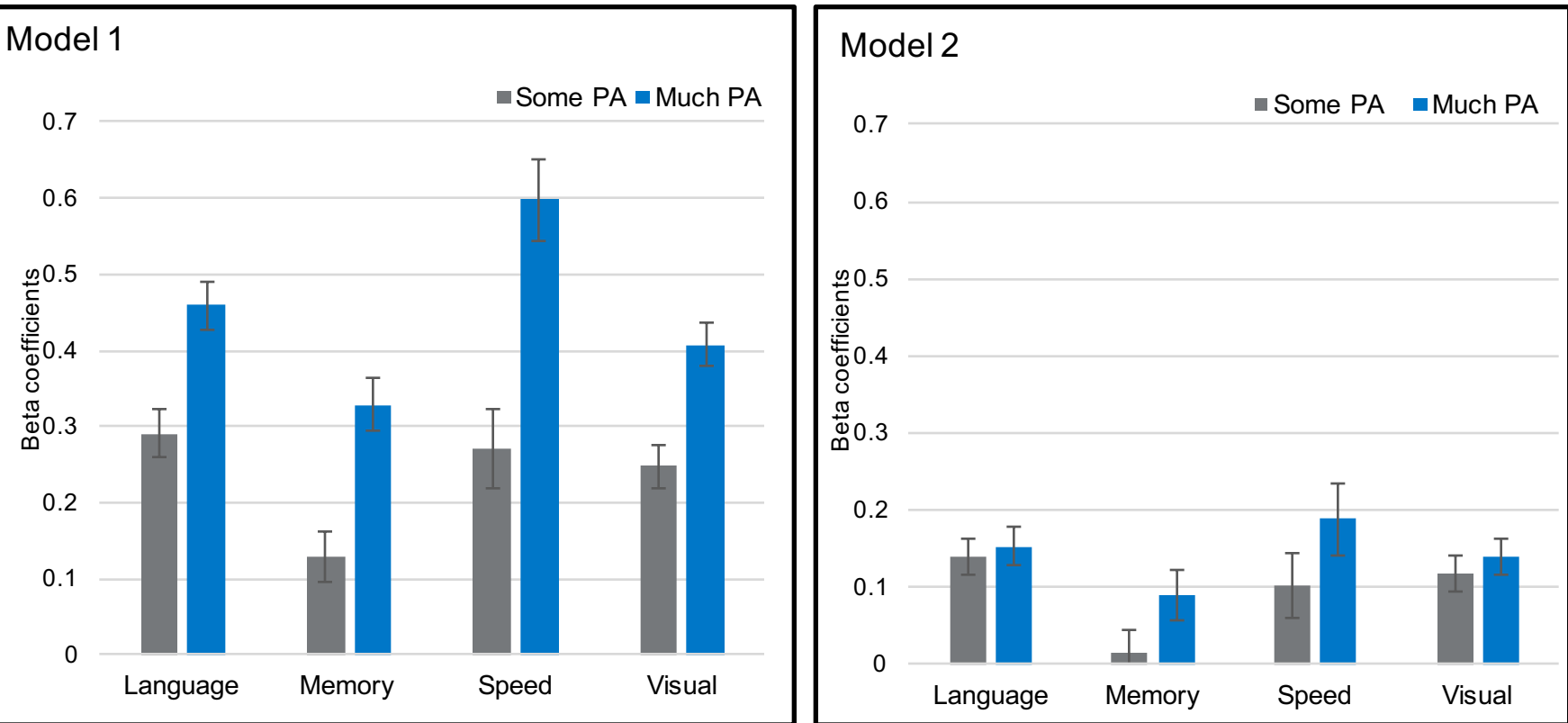


Table 3. Association between sleep index scores and cognition

Sleep index score β (95% CI)				
	Language	Memory	Speed	Visual
Model 1	-0.004 (-0.005, -0.002)	-0.002 (-0.004, -0.0003)	-0.007 (-0.010, -0.004)	-0.003 (-0.005, -0.002)
Model 2	-0.001 (-0.002, 0.0002)	-0.0003 (-0.002, 0.001)	-0.003 (-0.005, -0.001)	-0.001 (-0.002, 0.001)

Abbreviations: CI, Confidence interval; PA, Physical activity. **Bolded** values indicate statistically significance
Model 1: Crude model
Model 2: Adjusted model controlling for age, sex, education level, apolipoprotein E ϵ 4 allele, and comorbidity score

RESULTS

Table 4. Interaction between physical activity and sleep index for cognition in adjusted model

	Language	Memory	Speed	Visual
No PA x sleep index	0 Reference	0 Reference	0 Reference	0 Reference
Some PA x sleep index	0.001 (-0.002, 0.004)	0.001 (-0.002, 0.005)	0.003 (-0.002, 0.009)	0.001 (-0.002, 0.004)
Much PA x sleep index	0.001 (-0.002, 0.005)	0.002 (-0.002, 0.006)	0.001 (-0.005, 0.006)	0.00003 (-0.003, 0.003)

- Higher PA was associated with better cognition on all domains, adjusting for covariates.
- Having more sleep problems was associated with poorer cognitive performance.
- There was no interaction between PA and sleep for any of the cognitive scores.
- There was no mediation since adding sleep into the model did not attenuate the effect between PA and cognition ($\Delta B < 10\%$).

CONCLUSION

- Physical activity was associated with fewer sleep problems and better cognition
- A higher sleep index score, indicative of more sleep problems, was associated with lower cognition on all four domains.
- Sleep index did not modify nor mediate the association between physical activity and cognitive performance.
- Physical activity may have beneficial roles on cognition independent of sleep status.

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