Relationships between lifestyle factors, cerebral blood flow, and cognition in healthy older adults

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Background

- While there is evidence that physical activity (PA) can improve cognition and prevent cognitive decline, our understanding of the mechanisms through which PA exerts these effects remains unclear[1].
- Two recently proposed mechanisms which warrant further investigation are cerebral blood flow (CBF) and sleep efficiency[2].

Objectives

- To examine relationships between PA, sleep efficiency, CBF and cognitive ability in a sample of sedentary non-demented older adults
- To investigate sleep efficiency and global gray matter CBF as potential mediators of the relationship between PA and cognitive ability

Methods

Study Demographics	
N	47
M/F	15/32
Age	66.45 (6.79)
Edu	16.49 (2.47)
ApoE+/ ApoE-	13/34
MoCA	26.13 (2.36)
CVLT	21.89 (6.21)
Flanker	1.23 (.10)
Light PA	479.54 (243.66)
MVPA	31.77 (32.53)
Sleep Efficiency	.73 (.05)

Measures

Physical Activity and Sleep Efficiency

- Physical activity and sleep efficiency were measured using the GENEActiv accelerometer which participants wore 24 hours/day for 30 days preceding their in-person visit. Measures were averaged across days.
- Physical activity measures were categorized by gravitational acceleration units into light (30–100 mg) and moderate to vigorous PA (MVPA) (100+ mg)
- Sleep efficiency = time asleep / time in bed.

Cerebral Blood Flow

- Global gray matter CBF was quantified using a pseudo-continuous arterial spin labeling MRI scan

Neuropsychological Measures

- The Montreal Cognitive Assessment (MoCA), Flanker Task (ratio of congruent and incongruent trials – lower scores indicate better performance), and California Verbal Learning Test (CVLT) (short and long delay free recall) were used to assess cognitive ability

Statistical Analyses

- Linear regression analyses adjusting for age, sex, education and ApoE status were conducted to examine the relationships between PA, sleep efficiency, CBF, and cognitive ability.
- Indirect effects of PA on cognitive ability were assessed using sem from lavaan
- Exploratory analyses examined the role of gender in relationships between PA, sleep efficiency, CBF, and cognitive ability

References

1 Kramer, A. F., & Colcombe, S. (2018). Fitness effects on the cognitive function of older adults: a meta-analytic study—revisited. *Perspectives on Psychological Science*, *13*(2), 213-217.

2 Stillman, C. M., Cohen, J., Lehman, M. E., & Erickson, K. I. (2016). Mediators of physical activity on neurocognitive function: a review at multiple levels of analysis. *Frontiers in human neuroscience*, *10*, 626.

Results

- Sleep efficiency and global gray matter CBF are significantly related to global cognition
- No significant relationships between PA and cognition or between PA and sleep efficiency were observed. Relationships between PA and CBF were significantly related only in women.
- Cerebral blood flow was not a significant mediator of the relationship between PA and cognition.

A. Sleep Efficiency ~ Physical Activity

	Light PA	MVPA
Sleep Efficiency	β=2.76e^{-05}, p = .42	β=8.17e^{-05}, p = .77

B. Cognitive Ability ~ Sleep Efficiency

	MoCA	CVLT	Flanker
Sleep Efficiency	**β=13.10, p < .05**	β=19.37, p = .285	β=-0.54, p = .06

C. CBF ~ Physical Activity

	Light PA	MVPA
CBF	β=0.01, p = .11	β=0.01, p = .82

D. Cognitive Ability ~ CBF

	MoCA	CVLT	Flanker
CBF	**β=0.10, p < .05**	β=0.10, p = .42	β=0.003, p = .11

Table 1: Significant relationships are shown in bold. Models were adjusted for age, sex, education and ApoE status. MoCA = Montreal Cognitive Assessment total score; CVLT = California Verbal Learning Test short and long delay free recall; Flanker = Difference in reaction time for congruent and incongruent trials. Lower scores indicate better performance.

Higher levels of light physical activity predicts increased global gray matter CBF in women

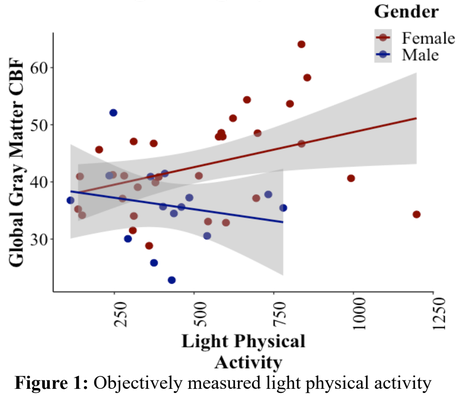

Figure 1: Objectively measured light physical activity is predictive of gray matter CBF in women ($p < .05$)

Higher sleep efficiency is associated with increased global gray matter CBF

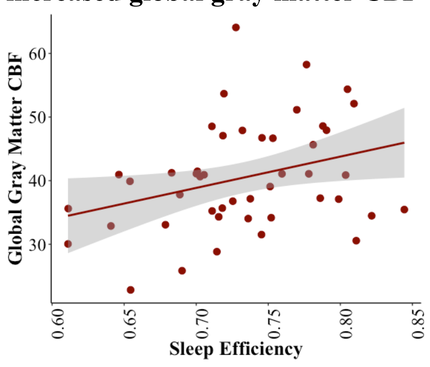

Figure 2: Objectively measured sleep efficiency is predictive of gray matter CBF across all subjects ($p < .05$)

Discussion

Conclusions

- The effect of light levels of physical activity on cerebral blood flow differs based on gender
- Cerebral blood flow and sleep efficiency may interact to influence cognitive ability, rather than through separate mechanisms

Future Directions

- Analyze day-to-day patterns of physical activity and sleep efficiency using time series analysis, and investigate how these patterns influence cognition and CBF.
- Investigate relationships between PA , sleep efficiency, cognition, and **ROI specific** CBF.

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