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NEUROLOOP GAIN ANALYSIS OF SLEEP SPINDLES CORRELATES WITH HIPPOCAMPUS VOLUME IN OLDER ADULTS

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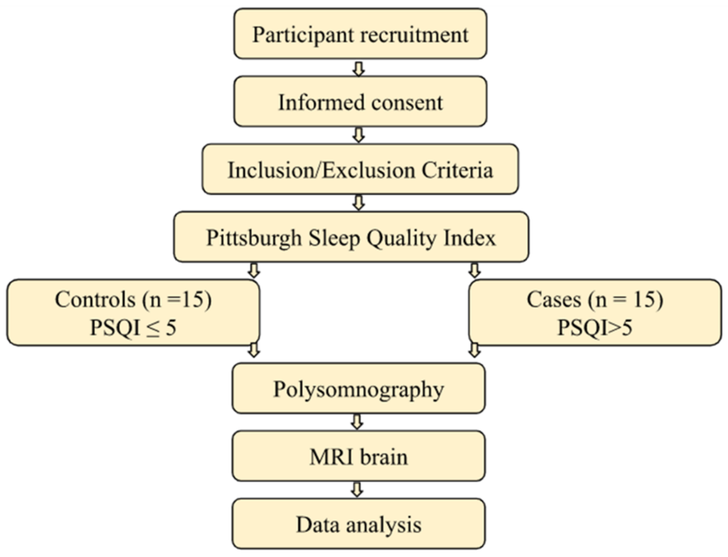
Background

Sleep spindles are neural oscillations of frequency between 11 to 16 Hz during non rapid eye movement sleep. They are coordinated with hippocampal ripples and slow oscillations to facilitate memory consolidation by modulating synaptic plasticity. Neuroloop gain analysis of sleep refers to the examination and evaluation of the feedback loop between the brain's neural activity and the regulation of sleep. It involves studying the interactions and feedback mechanisms between different brain regions, neural networks, and physiological processes during sleep to better understand the dynamics and regulation of sleep-wake cycles. The relationship between sleep architecture and hippocampus volume has not been characterized well, particularly in older adults.

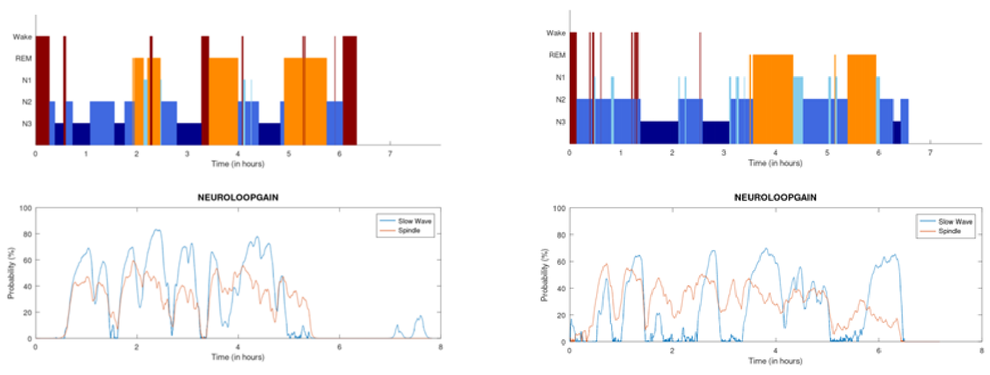
Methods

This is a cross sectional observational study conducted on 25 male participants (age 63.6+/-5.22 years). Good (n=12) and poor sleepers (n=13) were classified on the basis of PSQI score (<=5 is good quality sleep).
Overnight polysomnography was done and brain MRI was obtained. In DOMINO software, after artifact removal, sleep scoring was done as per AASM criteria.
Raw EEG data in EDF format was then exported to YASA (Yet Another Spindle Algorithm) sleep analysis toolbox and was analyzed in python using Spyder (Anaconda) platform.
Statistical Parametric Mapping (version SPM 12) based on MATLAB (R2020b) was used for anatomical MR data analysis.
The analysis steps included Segmentation (local-adaptive segmentation); topological correction and surface estimation; Region of interest (ROI) based surface extraction was done according to the DK-40 (Desikan Killiany atlas) and AAL3 (automated anatomical labeling atlas 3).
Statistical analysis was performed using GraphPad prism 9.

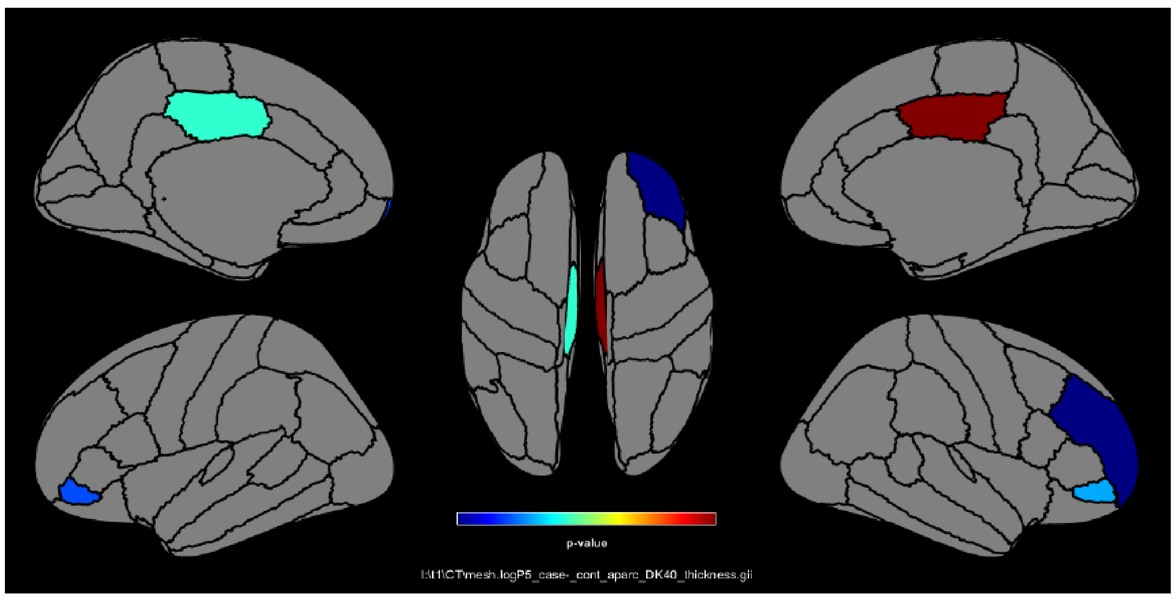


Results

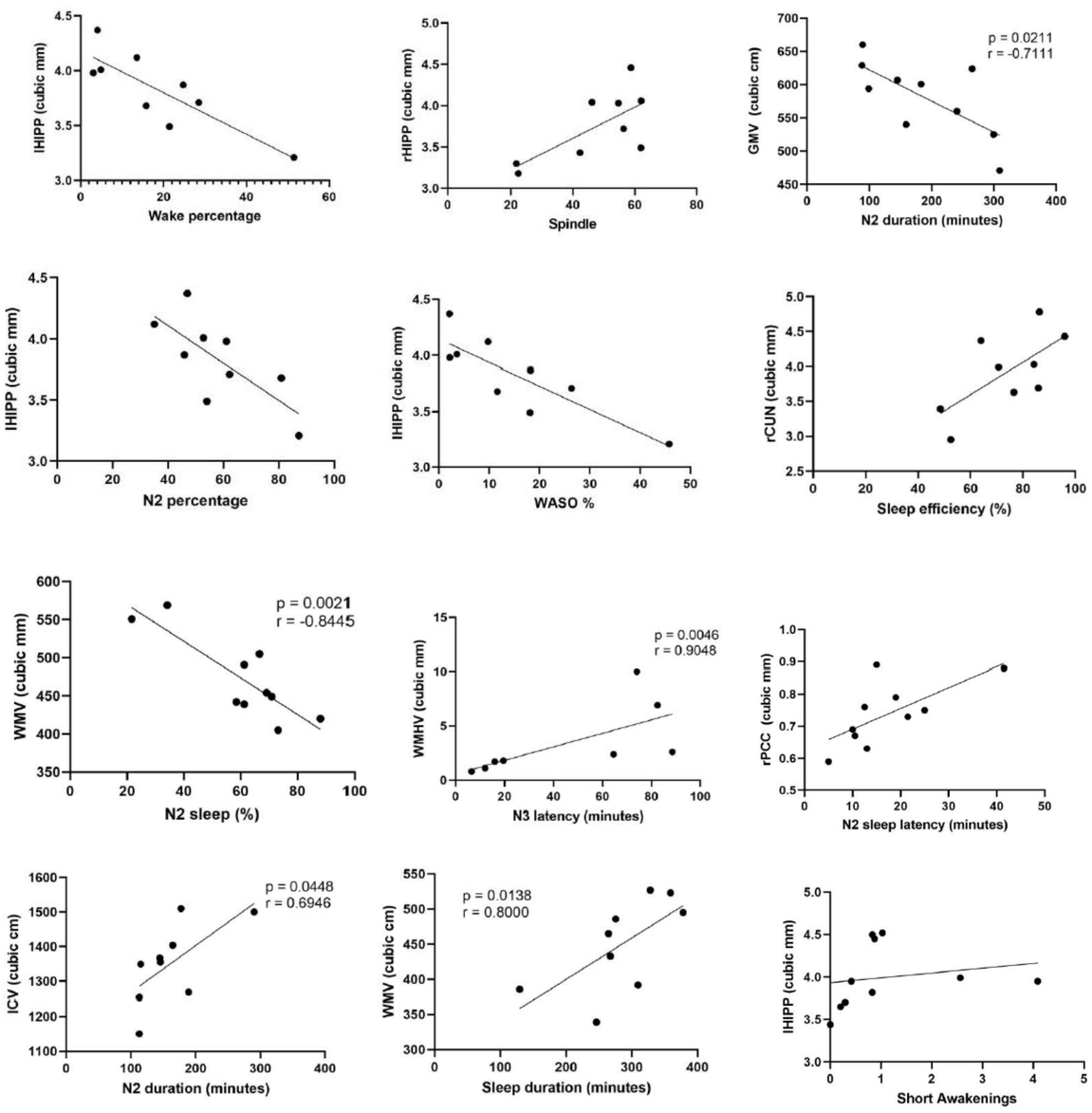
Among good sleepers, sleep efficiency was positively correlated with right cuneus volume (p = 0.037, r = 0.717). Left hippocampal volume was negatively correlated with wake duration (p = 0.031, r= -0.773) and wake percentage (p = 0.025, r= -0.750), WASO duration (p = 0.025, r= -0.750) and WASO percentage (p = 0.014, r= -0.800), and N2 sleep latency (p = 0.025, r= -0.750). Total intracranial volume was found to be positively correlated with N2 sleep duration (p= 0.0448, r= -0.8445). Neuroloop spindles were positively correlated with right hippocampal volume (p = 0.037, r= 0.717)



Representative hypnograms of good sleepers and corresponding spindle and slow wave probability. Created using YASA (Yet Another Spindle Algorithm) sleep analysis toolbox in python using Spyder (Anaconda) platform.



Cortical thickness comparison of left and right hemisphere between good and poor sleepers. Color indicates areas having significantly different cortical thickness in good and poor sleepers, with lower p value towards red extreme and higher p value towards the blue extreme. Created using SPM-MATLAB. Left hemisphere, up to down: posterior cingulate orbitalis. and pars orbitalis. Right hemisphere, up to down: posterior cingulate orbitalis, rostral medial frontal, and pars orbitalis.



Conclusion

There is a positive correlation between spindle generation probability and right hippocampal volume in older adults who are good sleepers.

References

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2. Sullivan D, Mizuseki K, Sorgi A, Buzsáki G. Comparison of sleep spindles and theta oscillations in the hippocampus. J Neurosci. 2014 Jan 8;34(2):662-74. doi: 10.1523/JNEUROSCI.0552-13.2014.

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