Subjective sleep dysfunction and daytime sleepiness linked to resting-state EEG and cognitive performance in Alzheimer's and Parkinson's disease

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Background

Sleep alterations and excessive daytime sleepiness are common in neurodegenerative conditions such as Alzheimer's disease (AD) and Parkinson's disease (PD),[1,2] and may reflect **disrupted vigilance regulation** [3] playing a role in overall cognitive decline. This study examined the associations between subjective sleep variables, daytime functioning, resting-state EEG rhythms, and cognitive performance, as assessed via serious games within the **SmartMe&You platform** (https://smartme.cloud.garr.it/) in older adults with and without cognitive impairment.

Materials and methods

As part of the eBRAIN-Health (European Commission Horizon grant), PREDICT-NEURODEGEN (Italian Ministry of Health grant), and TELEMAIA (Regione Lazio Innova grant) projects, 64 older adults – **22 healthy controls** (HC; mean age: 66.6 ± 6.2, 9 women), **15 with cognitive decline due to AD** (ADCD; mean age: 74.5 ± 6.8, 5 women), **and 28 with cognitive decline due to PD** (PDCD; mean age: 74.8 ± 6.1, 6 women) – completed standardized **sleep questionnaires**, **32-channel EEG**, and home-based cognitive assessment using seven **SmartMe&You serious games**. Participants completed the Pittsburgh Sleep Quality Index (PSQI; total and seven component scores, which assesses diverse domains of subjective sleep quality and quantity) and the Epworth Sleepiness Scale (ESS), and performed tablet-based SmartMe&You tasks targeting attention and visuomotor speed. Resting-state EEG (~5 min, eyes closed) was analyzed using eLORETA to extract source-level current density estimates in individual delta, theta, alpha1, alpha2, and alpha3 frequency bands. ANCOVAs were used to test group differences controlling for age, sex, and education, while Spearman's correlations examined the associations among EEG, subjective sleep quality, sleepiness, and serious games cognitive performance.

Results

Both cognitively impaired groups (ADCD and PDCD) showed significantly higher PSQI (p=.01, η2p=.16) and ESS (p=.02, η^2_p=.13) scores than HC. Delta (p=.01, η^2_p=.18) and theta (p=.03, η^2_p=.12) EEG source activities were increased in ADCD and PDCD (**Figure 1**). ESS and the PSQI component for daytime dysfunction (C7) were positively associated with delta (rho=.36 and .39) and theta (rho=.38 and .42) current densities (all p<.01), and both measures negatively correlated with game accuracy (rho=–.38 for ESS and rho=–.43 for PSQI C7 with p<.01) (**Figure 2**). Moreover, worse overall sleep quality was associated to reduced cognitive performance (rho=–.38, p<.01).

Table 1

DEMOGRAPHIC AND CLINICAL CHARACTERISTICS				
	ADCD (n = 15)	PDCD (n = 28)	HC (n = 22)	Statistical analyses
Age (years)	74.5 ± 6.8	74.8 ± 6.1	66.6 ± 6.2	ANOVA: p<.001 (HC < ADCD; HC < PDCD)
Sex (M/F)	10/5	22/6	13/9	Fisher's test: n.s.
Education (years)	11.9 ± 3.6	12.4 ± 4.4	14.7 ± 3.8	ANOVA: n.s.
MMSE score	25.8 ± 3.1	26.1 ± 3.9	29.4 ± 1.0	Kruskall-Wallis test: p<.001 (HC > ADCD; HC > PDCD)

Figure 1

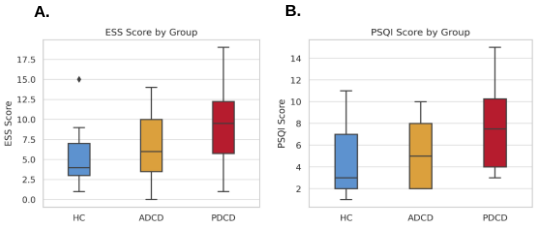
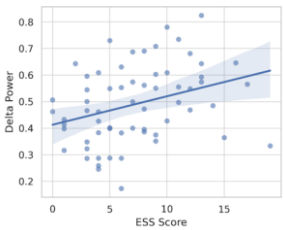


Figure 2



Conclusions

These findings suggest that poor sleep-related daytime functioning is accompanied by increased slow-wave resting-state EEG activity and reduced cognitive performance in older adults with neurodegenerative conditions. The SmartMe&You platform, combined with EEG and subjective sleep measures, offers a scalable and ecologically valid technology for detecting neurobehavioral alterations in AD and PD with cognitive impairment. Findings support the value of cognitive- and sleep-focused monitoring in age-related cognitive decline, encouraging further efforts in prolonged home-based monitoring of rest-activity rhythms.

References

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