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CPAP Adherence May Slow 1-Year Cognitive Decline in Older Adults with Mild Cognitive Impairment and Apnea

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Abstract

BACKGROUND/OBJECTIVES: Obstructive sleep apnea (OSA) has been linked to increased risk for Alzheimer's disease (AD), but little prospective evidence exists on the effects of OSA treatment in preclinical AD. The objective was to determine if CPAP treatment adherence,

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ADDITIONAL AWARDS
CPAP Equipment provided by Philips Respironics, Inc.

controlling for baseline differences, predicts cognitive and everyday function after 1 year in older adults with mild cognitive impairment (MCI) and to determine effect sizes for a larger trial.

Trial registration number: Memories; NCT01482351; https://clinicaltrials.gov/ct2/show/NCT01482351?cond=MCI+and+OSA&rank=1

DESIGN: Quasi-experimental pilot clinical trial with CPAP adherence defined as CPAP use ≥ 4 hours per night over 1 year.

SETTING: Sleep and geriatric clinics and community.

PARTICIPANTS: Older adults, aged 55–89 years, with apnea-hypopnea index ≥ 10, participated: 1) MCI, OSA, and CPAP adherent (MCI+CPAP), n=29; and 2) MCI, OSA, CPAP non-adherent (MCI-CPAP), n=25.

INTERVENTION: CPAP.

MEASUREMENTS: The primary cognitive outcome was memory (Hopkins Verbal Learning Test-Revised) and the secondary cognitive outcome was psychomotor/ cognitive processing speed (Digit Symbol -DS). Secondary function and progression measures were the Everyday Cognition, Alzheimer's Disease Cooperative Study-Clinical Global Impression of Change Scale, and Clinical Dementia Rating.

RESULTS: Statistically significant improvements in psychomotor/cognitive processing speed in the MCI+CPAP group versus the MCI-CPAP group were observed at 1 year after adjustment for age, race, and marital status (PE=1.68, SE=0.47, 95% CI=0.73–2.62), with a 6-month effect size (ES) of 0.46 and a 1-year ES of 1.25. There were small to moderate effect sizes for memory (ES 0.20, 6 months), attention (ES 0.25, 1 year), daytime sleepiness (ES 0.33, 6 months and ES 0.22, 1 year), and everyday function (ES 0.50, 6 months) favoring the MCI+CPAP group versus the MCI-CPAP group.

CONCLUSION: Controlling for baseline differences, 1 year of CPAP adherence in MCI+OSA significantly improved cognition, compared to a non-adherent control group, and may slow the trajectory of cognitive decline.

Keywords

mild cognitive impairment; obstructive sleep apnea; CPAP; neurocognitive outcome; Memories

INTRODUCTION

Mild cognitive impairment (MCI), characterized by memory impairment but little or no decline in everyday function, is a transitional stage between normal aging and Alzheimer's disease (AD). A growing number of studies suggest that obstructive sleep apnea (OSA) is associated with an increased risk of cognitive impairment.[1–2] OSA, a prevalent condition in older adults with MCI and AD [3] is characterized by episodic nocturnal airway collapse, reducing or stopping respiration and causing hypoxia, and disturbed sleep. OSA is treated with continuous positive airway pressure (CPAP), a pressurized mask worn during sleep, but few studies have confirmed if treatment delays cognitive decline.

The aim of this pilot clinical trial (Memories 1) was to determine whether CPAP treatment adherence predicts cognitive and everyday function after 1 year in older adults with MCI and to determine effect sizes for a larger trial. We hypothesized that cognitive and everyday function would be improved.

METHODS

Design

Although CPAP eliminates OSA, it must be consistently used for at least 4 hours per night for a therapeutic response, [4] and only 30–60% of individuals prescribed CPAP adhere to it.[5] An advantage of a design incorporating CPAP adherence is that CPAP systems record use. This quasi-experimental study had 2 comparison groups: 1) an MCI, OSA, and CPAP adherent group (MCI+CPAP, ≥4 hr mean CPAP use per night for 1 year); and (2) an MCI, OSA, CPAP non-adherent group (MCI-CPAP, <4 hr mean CPAP use per night for 1 year). We also recruited an MCI without OSA group (n=15), but these results are not reported here. [6] The study was approved by the Institutional Review Boards and registered with ClinicalTrials.gov (NCT01482351).

Settings and Sample

Participants were identified primarily through sleep and geriatric clinics (see Supplementary Figure S1). Enrollment was from September, 2012, through December, 2014. The final sample at 1 year consisted of 54 older adults with MCI: (1) MCI+CPAP, n = 29; and (2) MCI–CPAP, n = 25. Data analysis and manuscript preparation occurred January, 2015, through February, 2018.

Inclusions: (1) age 55–89 years; (2) OSA defined as an apnea-hypopnea index (AHI) ≥10, using either a split- or whole-night polysomnography. We chose an AHI cut-off of ≥10 as opposed to ≥15, the conventional cut-off for moderate OSA, because split-night studies underestimate the AHI;[7] (3) amnestic MCI (single and multiple domain) based on Peterson criteria and decision rules [8–10]: a) memory complaint, verified by informant; b) 0–0.5 on the Clinical Dementia Rating (CDR)[11]; c) normal general cognition, 24–30 on the Mini-Mental State Examination (MMSE);[12] d) memory impairment, approximately 1.0–1.5 standard deviations below normal (adjusted for age and education) on the Logical Memory II test;[13] e) performance approximately 1.0–1.5 standard deviations below normal (adjusted for age and education) in no more than one cognitive domain in addition to memory; (4) medications stable for at least 4 weeks; washout from psychoactive medications for 4 weeks; (5) score of ≤28 on the 21-item Beck Depression Inventory II;[14] (6) a study partner; and (7) 6 or more grades of education, or a history to exclude intellectual disability.

Exclusions: (1) significant neurologic disease other than MCI; (2) MRI exclusions, e.g. metal; (3) psychiatric disorders, e.g. uncontrolled major depression; (4) history of alcohol dependence within 6 months; (5) unstable medical condition; (6) participation in studies involving neuropsychological testing; (7) currently receiving CPAP; (8) requiring oxygen; (9) dementia indicated by impairment in 3–5 age and education adjusted cognitive domains.

OSA Measures

Polysomnography.—All participants underwent either a full-night diagnostic polysomnography and a full-night CPAP titration, or a split-night diagnostic and CPAP titration polysomnography, in an accredited in-laboratory setting. Polysomnography was performed in accordance with American Academy of Sleep Medicine (AASM).[15]

CPAP Adherence and Attention Control Interventions

Project staff provided each participant with a comprehensive CPAP adherence intervention. If, at any time during the 1 year study, participants elected not to continue to try to use CPAP, or their CPAP unit was taken away by their insurance company for non-use, staff provided an attention control intervention (see Supplementary Table S2).

Outcome Measures and Blinding

The neuropsychological testers were blinded to group membership. They measured outcomes at baseline, 6 months, and 1 year.

Primary Outcomes.

Cognitive Function: Memory was measured with the Hopkins Verbal Learning Test–Revised (HVLT-R) total recall, [16] Psychomotor/cognitive processing speed was measured with the Digit Symbol subtest (DS) from the Wechsler Adult Intelligence Scale (WAIS-R) age-adjusted total scaled score.[17,18]

Secondary Cognitive Function Outcomes: Global cognition was assessed with the MMSE. Attention was measured with the Stroop Color and Word test (SCW) [19] and the Psychomotor Vigilance Task (PVT)[20] transformed number of lapses. Daytime sleepiness was measured with the Epworth Sleepiness Scale (ESS).[21]

Secondary Outcomes.

Everyday function and Progression: Function was measured with the study-partner rated Everyday Cognition (ECog).[22] and the OSA-specific Functional Outcomes of Sleep Questionnaire (FOSQ).[23] Participants' view of change at 1 year was measured with the Alzheimer's Disease Cooperative Study–Clinical Global Impression of Change Scale (ADCS-CGIC).[24] Progression was assessed with the Clinical Dementia Rating (CDR).

Sample Size

The pilot study was prospectively powered to detect a significant difference in the HVLT-R. Because no similar studies had been done, estimates were based on a study of older adults with AD and OSA[25] and assumed a mean score of 8.0 at baseline for the HVLT-R, with a standard deviation of 2.4. As such, 35 participants in the MCI-CPAP group and 75 participants in the MCI+CPAP group achieved 81% power to detect a 1-unit improvement in the HVLT-R. Although we were unable to recruit the desired sample size, 29 in the MCI +CPAP group, 25 in the MCI-CPAP group was sufficient to show a significant difference in the secondary cognitive function outcome, and allowed effect size estimates for a larger study.

Statistical Analysis

Differences in baseline characteristics between the MCI-CPAP and the MCI+CPAP adherence groups were examined. Within-group changes from baseline to 6 months and baseline to 1 year were evaluated. Separate unadjusted and adjusted general linear models were generated for change from baseline to 6 months and baseline to 1 year, where the outcome was regressed on adherence group. Model assumptions were assessed; to protect against violations in the homoscedasticity assumption, the robust variance estimator (Huber Sandwich Estimator) was used to estimate the variance of the maximum likelihood estimates. Adherence group differences in least square mean estimates, divided by the estimated variation obtained using mean square error, were used to estimate between-group effect sizes using the adjusted general linear model results. Separate unadjusted and adjusted logistic regression models were generated for improvement on the CDR and ADCS-CGIC, where each outcome was regressed on adherence group. All regression models were adjusted for age, race, and marital status to account for significant baseline group differences. Statistical significance was at the 0.05 level. Analyses were performed with SAS software (version 9.4, SAS Institute, Cary, NC).

RESULTS

Participants

There were 68 MCI+OSA participants at baseline, and 14 (21%) dropped out during the 1 year follow-up (Supplementary Figure S1). We compared the dropouts with completers on age; sex; marital status; education; race; OSA severity; ApoE4; cognition enhancing medications; cognitive and everyday function, and daytime sleepiness. The only differences were in ApoE4 genotype and marital status. Participants were more likely to drop out if they were ApoE4 negative (<0.001). Those who were married were more likely to stay in the study (p =0.01), and marital status was used as a covariate in general linear modeling.

For the total sample, the mean age was 70.1±8.3 years, 44.4% were female, and 64.8% were white. The MCI-CPAP group was significantly older; and significantly fewer were white and married (Table 1). Potential adverse events occurred in 5 participants without any permanent sequelae, all of whom were in the MCI+CPAP group, but none were deemed to be treatment related.

6-Month and 1-Year Outcomes

In the MCI+CPAP group, significant increases in psychomotor/cognitive processing (DS) were observed from baseline to 6 months (change=0.64) and baseline to 1 year (change=1.02) (Table 2). There were also significant decreases in daytime sleepiness in the MCI+CPAP group from baseline to 6 months (change=−1.96) and baseline to 1 year (change=−2.12). In the MCI-CPAP group, attention significantly improved from baseline to 6 months (change=−2.23) and baseline to 1 year (change=−1.66). Significant decreases in global cognition were observed from baseline to 1 year (change=−1.61) in the MCI-CPAP group.

Table 3 summarizes the unadjusted and adjusted general linear regression model results for the change in outcomes from baseline to 1 year. Statistically significant improvements in psychomotor/cognitive processing speed in the MCI+CPAP group versus the MCI-CPAP group were observed at 1 year after adjustment for age, race, and marital status (Table 3, PE=1.68, SE=0.47, 95% CI=0.73–2.62), with a 6-month effect size (ES) of 0.46 and a 1-year ES of 1.25. There were small to moderate effect sizes for memory (ES 0.20, 6 months), attention (ES 0.25, 1 year), daytime sleepiness (ES 0.33, 6 months and ES 0.22, 1 year), and everyday function (ES 0.50, 6 months) favoring the MCI+CPAP group versus the MCI-CPAP group.

Data on the CDR were missing in 12 individuals because we were unable to contact their study partners prior to study closure. During the 1-year study, 21 participants improved on the CDR, while 21 worsened or stayed the same. The MCI+CPAP group had an over 2-fold increased odds of improving on the CDR as compared to the MCI-CPAP group, adjusting for age, race, and marital status (OR=2.16, 95% CI=0.38–12.42, p=0.39). Data were missing on the ADCS-CGIC in 12 individuals because data were not collected (n = 12). Thirty-four participants rated themselves as improving over 1 year, and 7 reported that they had worsened or were unchanged. The MCI+CPAP group demonstrated an over 5-fold increased odds of improving on the ADCS-CGIC self-report as compared to the MCI-CPAP group, adjusting for age, race, and marital status (OR=5.31, 95% CI=0.63–44.86, p=0.12) (Supplementary Table S3). The findings from these logistic regression models are clinically important, but not statistically significant due to our small sample size.

DISCUSSION

Our research revealed a statistically significant beneficial effect of CPAP adherence, controlling for age, race, and marital status, on psychomotor/cognitive processing speed with a moderate to large ES at 1 year, and small to moderate effect sizes across multiple domains of cognitive function in persons with MCI and OSA. Although this was a pilot study, our data show a pattern of benefits for CPAP adherence in older adults with MCI+OSA. A larger, adequately powered study is needed to confirm our findings.

Strengths of this research include recruitment from diverse settings, a well-characterized sample, equal attention to both groups, blinding of the outcome assessors to adherence data, a low trial attrition, and 1-year follow-up. Although we compared the MCI+CPAP and the MCI-CPAP groups on 22 potential baseline confounders, and controlled for the differences in our analysis, the groups may have been different on unidentified variables that may have affected the study outcomes. Like others,[26]we found that whites were more likely to adhere to CPAP, and we controlled for race in the data analysis. We also controlled for marital status. The MCI+CPAP group involved more married/cohabitating participants, which may contribute to CPAP adherence,[27] and may protect against cognitive decline.[28]

Frequent phone calls and a newsletter resulted in a good 1-year participant retention, but 22% of participants had missing 12-month CDR data because study partners were unavailable. Future studies might compensate study partners. Investigators also should consider measuring amyloid burden and total sleep time using actigraphy to determine if

there are differences at baseline between adherence groups. While we based our definition of CPAP adherence on evidence-based recommendations,[29] a higher mean CPAP use over 1 year might have had a larger effect.[30] In general, our sample was not excessively sleepy. However,future larger studies might examine changes in neurocognitive function related to CPAP adherence in those with and without excessive daytime sleepiness. We anticipated that CPAP adherence would result in larger effects on HVLT-R memory. Mean scores, however, changed little over 1 year in both study groups, indicating that the HVLT may not be a sensitive measure of memory over 1 year in this population.

The DS is sensitive to many conditions that influence cognitive performance, but it has not been shown to be a specific indicator of cognitive function or changes in cognitive function in persons with MCI. However, in our study, it was quite sensitive to differences in CPAP adherence and had larger effect sizes than did other cognitive measures at both 6 months and 1 year. The DS taps an information-processing inefficiency that may be a central feature of the cognitive deficit in persons with MCI+OSA. Future studies might use implicit learning tests to assess the recall of symbol-digit relations to help determine the role that sub-processes might play in coding tasks or regression-based approaches in which coding performance is correlated with additional neuropsychological tests that assess specific cognitive domains.

To our knowledge, Memories 1 is the first prospective clinical trial to show that CPAP adherence in MCI+OSA significantly improves cognitive function. Further, while not statistically significant because of the pilot nature of this study, the MCI+CPAP group reported an over 5-fold increased odds (p=0.12) of perceiving that they had improved, as compared to the MCI-CPAP group, and this is important from a clinical perspective because it represents an outcome that matters to individuals.[5] Clinicians should screen for OSA in older adults with MCI and treat it.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in theonline version of this article.

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Impact Statement

We certify that this work is novel clinical research. The potential impact of this research on clinical care includes the following: 1) comorbid obstructive sleep apnea (OSA) may be a contributing cause for cognitive decline in older adults with mild cognitive impairment, and 2) adherence to continuous positive airway pressure treatment of OSA in older adults with comorbid mild cognitive impairment and OSA significantly improves cognition over 1 year, and may slow the long-term trajectory of cognitive decline. These findings expand diagnostic and treatment options for older adults with preclinical Alzheimer's disease.

Table 1.

Demographics, clinical and sleep characteristics of study groups at baseline (n = 54)

Variable	MCI+CPAP, n = 29	MCI-CPAP, n = 25	P-Value
Demographics			
Age, mean ± SD	67.4 ± 7.2	73.2 ± 8.6	.01 [1]
Sex, female, n (%) [a]	9 (31.0)	15 (60.0)	.05 [2]
Race, white, n (%) [a]	24 (82.8)	11 (44.0)	≤.01 [2]
Education, > high school, n (%) [a]	26 (89.7)	21 (44.0)	.15 [2]
Married/cohabitate, n (%) [b]	23 (82.1), n=28	8 (32.0), n=25	<.001 [2]
BMI, mean ± SD	30.3±6.7	29.5±6.5	.65 [1]
Income n (%) [b]	n=24	n=21	.10 [3]
<$20,000	3 (12.5)	9 (42.9)	
$20,000 – $39,999	2 (8.3)	2 (9.5)	
$40,000 – $69,999	3 (12.5)	4 (19.0)	
$70,000 – $99,999	4 (16.7)	2 (9.5)	
≥$100,000	12 (50.0)	4 (19.0)	
Study Partner, n (%) [a]			<.001 [2]
Spouse/cohabitate	26 (89.7)	9 (36.0)	
Adult child	1 (3.4)	6 (24.0)	
Other	2 (6.9)	10 (40.0)	
Reported/known conditions [a]			
Diabetes, n (%)	7 (24.1)	8 (32)	.56 [2]
Cardiovascular disease n (%)	11 (37.9)	14 (56.0)	.27 [2]
Hypertension n (%)	15 (51.7)	14 (56.0)	.79 [2]
APOE [b], **n (%)**	n=27	n=25	.14 [3]
E2/E2	0 (0.0)	1 (4.0)	
E2/E3	1 (3.7)	0 (0.0)	
E2/E4	1 (3.7)	0 (0.0)	
E3/E3	16 (59.3)	18 (72.0)	
E3/E4	9 (33.3)	4 (16.0)	
E4/E4	0 (0.0)	2 (8.0)	
Medications, n (%) [a]			
Cholinesterase inhibitors	1 (3.4)	2 (8.0)	.59 [4]
NMDA Receptor Antagonists	0 (0.0)	0 (0.0)	
Opioid Analgesics	0 (0.0)	3 (12.0)	.09 [4]
Antidepressants	6 (20.7)	1 (4.0)	.11 [4]

Variable	MCI+CPAP, n = 29	MCI-CPAP, n = 25	P-Value
Sedative/anxiolytics	5 (17.2)	5 (20.0)	>.99 [4]
Antihypertensives	19 (65.5)	21 (84.0)	.21 [2]
Clinical Characteristics, mean ± SD			
MMSE	28.3±1.4	28.0±2.1	.49 [1]
ESS	8.5±3.5	9.3±5.3	.52 [1]
BDI II	7.7±4.6	6.4±6.6	.42 [1]
PSG baseline (N=38)			
Total sleep time (min)	283.2±84.0	270.5±95.9	.71 [1]
Apnea-hypopnea index	25.3±11.5	31.1±20.8	.43 [1]
Lowest oxygen saturation (%)	82.3±6.9	81.8±5.0	.83 [1]
PSG split night (N=16)			
Total sleep time (min)	218.2±150.6	150.4±77.4	.30 [1]
Apnea-hypopnea index	25.6±9.2	14.6±7.8	.04 [1]
Lowest oxygen saturation (%)	86.0±5.0	82.9±6.3	.40 [1]

[1]Two-sample t-test.

[2]Chi-square test.

[3]Fisher's exact test.

[4]Yates' chi-square test.

[a]Percentages are derived using column total in sample.

[b]Percentages are derived from column total minus the number of participants in the group who did not provide data for this variable.

SD = standard deviation; MCI = mild cognitive impairment; +CPAP = continuous positive airway pressure adherent defined as mean use >=4 hours/night; -CPAP = continuous positive airway pressure non-adherent defined as mean use <4 hours/night; BMI = body mass index; APOE = apolipoprotein; NMDA = N-methyl-D-aspartate; MMSE = mini-mental state examination; CDR = clinical dementia rating; ESS = epworth sleepiness scale; BDI II = beck depression inventory; ARES = apnea risk evaluation system; PSG = polysomnography.

Table 2.

Descriptive statistics of cognitive and everyday function at baseline, 6 months, and 1 year

Cognitive and functional domains	Baseline Mean(SD) [Change]		6-month Mean (SD) [Change]		1 year Mean (SD) [Change]	
	MCI+CPAP, n = 29	MCI-CPAP, n = 25	MCI+CPAP, n = 29	MCI-CPAP, n = 25	MCI+CPAP, n = 29	MCI-CPAP, n = 25
Cognition						
Memory HVLT	23.52(5.56)	20.04(5.30)	23.68(5.08) [0.16] n=28	20.39(5.48) [0.35] n=23	23.59(5.73) [0.07] n=29	20.82(5.69) [0.41] n=22
Psychomotor/Cognitive Processing DS	9.18(2.59) n=29	8.06(2.65) n=25	9.90(2.74) [0.64]* n=28	8.02(2.36) [0.17] n=23	10.21(3.03) [1.02]* n=29	8.09(2.78) [−0.09] n=23
Global Cognition MMSE	28.34(1.40)	28.00(2.10)	28.61(1.62) [0.28] n=28	27.48(2.00) [−0.46] n=23	27.93(2.05) [−0.41] n=29	26.43(2.46) [−1.61]* n=23
Attention PVT	3.09(1.53)	6.46(3.66) n=24	2.58(1.64) [−0.56] n=27	4.29(2.71) [−2.23]* n=23	2.77(1.91) [−0.32] n=29	4.76(2.94) [−1.66]* n=22
SCW	47.36(6.15) n=28	44.28(8.19) n=25	48.22(8.20) [0.95] n=27	45.36(8.57) [1.16] n=22	50.00(7.40) [2.64] n=28	45.14(9.47) [1.06] n=22
Daytime Sleepiness ESS	8.50(3.52) n=28	9.32(5.34) n=25	6.54(3.17) [−1.96]* n=26	8.00(5.53) [−2.10]* n=20	6.34(3.71) [−2.12]* n=29	7.57(4.37) [−1.66] n=23
Everyday Function						
ECog	1.46(0.54) n=26	1.29(0.41) n=25	1.35(0.36) [−0.04] n=26	1.43(0.52) [0.16]* n=19	1.35(0.51) [−0.10] n=23	1.52(0.70) [0.24]* n=20
FOSQ	17.31(1.99) n=25	17.34(2.66) n=25	18.17(1.48) [0.76]* n=27	18.13(2.14) [0.92] n=21	18.30(1.82) [0.96]* n=29	18.63(1.95) [1.25]* n=23

* p< .05.

SD = standard deviation; MCI = mild cognitive impairment; +CPAP = continuous positive airway pressure adherent defined as mean use >=4 hours/night; -CPAP = continuous positive airway pressure non-adherent defined as mean use <4 hours/night; HVLT = hopkins verbal learning test; DS = digit symbol; MMSE = mini mental state exam; SCW = stroop color and word; PVT = psychomotor vigilance test; ESS = epworth sleepiness scale; ECog =everyday cognition; FOSQ = functional outcomes of sleep questionnaire;

Participant numbers differ across time points and measures due to incomplete data and/or unavailability of care partners.

Table 3.

Unadjusted and adjusted general linear model results for changes in cognitive and everyday function at 1 year

Dependent Variable: Cognitive and functional domains	Unadjusted Model	Adjusted Model			
	Adherence Group (MCI+CPAP *vs.* MCI-CPAP)	Age (years)	Race (White *vs.* Other)	Marital Status (Married *vs.* Other)	Adherence Group (MCI+CPAP *vs.* MCI-CPAP)
Cognition					
HVLT					
PE	−0.02	−0.03	2.51	−0.92	−0.55
SE	1.32	0.09	1.80	1.77	1.66
95% CI	−2.67—2.63	−0.22—0.15	−1.12—6.13	−4.48—2.64	−3.90—2.81
DS					
PE	1.12	−0.01	−0.68	−0.54	1.68
SE	0.40	0.03	0.50	0.50	0.47
95% CI	0.32—1.92 *	−0.06—0.05	−1.70—0.33	−1.54—0.46	0.73—2.62 *
MMSE					
PE	1.24	−0.04	1.34	0.05	0.33
SE	0.58	0.04	0.73	0.72	0.68
95% CI	0.08—2.39 *	−0.12—0.03	−0.14—2.81	−1.40—1.51	−1.04—1.70
PVT					
PE	1.27	−0.02	1.16	−0.06	0.73
SE	0.82	0.06	1.20	1.18	1.06
95% CI	−0.37—2.91	−0.13—0.10	−1.24—3.57	−2.45—2.32	−1.40—2.87
SCW					
PE	0.37	0.02	−0.62	−1.31	1.15
SE	2.63	0.19	3.64	3.58	3.39
95% CI	−4.92—5.66	−0.37—0.40	−7.95—6.71	−8.52—5.91	−0.68—7.98
ESS					
PE	−0.46	0.07	−1.77	2.74	−0.87
SE	1.10	0.07	1.52	1.55	1.39
95% CI	−2.67—1.74	−0.08—0.22	−4.83—1.28	−0.38—5.87	−3.66—1.93
Everyday function					
ECog					
PE	−0.34	0.01	0.01	−0.43	0.04
SE	0.15	0.01	.17	0.19	0.16
95% CI	−0.63—−0.04 *	−0.01—0.03	−0.34—0.36	−0.82—0.04	−0.28—0.36
FOSQ					
PE	−0.24	−0.05	0.21	−0.95	−0.09
SE	0.63	0.04	0.86	0.86	0.79
95% CI	−1.46—1.03	−0.14—0.04	−1.54—1.94	−2.72—0.82	−1.69—1.51

* $p < .05$.

MCI = mild cognitive impairment; +CPAP = continuous positive airway pressure adherent defined as mean use >=4 hours/night; -CPAP = continuous positive airway pressure non-adherent defined as mean use <4 hours/night; HVLT = hopkins verbal learning test; DS = digit symbol; MMSE = mini mental state exam; SCW = stroop color and word; PVT = psychomotor vigilance test; ESS = epworth sleepiness scale; ECog =everyday cognition; FOSQ = functional outcomes of sleep questionnaire; PE = parameter estimate; SE = standard error; 95% CI = 95% confidence interval.