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Research Article

Sleep, Circadian Rhythms, and Aging: Advancing Knowledge to Promote Older Adults' Health

Predictors of Adherence to Continuous Positive Airway Pressure in Older Adults With Apnea and Amnestic Mild Cognitive Impairment

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Abstract

Background: Almost 60% of adults with amnestic mild cognitive impairment (aMCI) have obstructive sleep apnea (OSA). Treatment with continuous positive airway pressure (CPAP) may delay cognitive decline, but CPAP adherence is often suboptimal. In this study, we report predictors of CPAP adherence in older adults with aMCI who have increased odds of progressing to dementia, particularly due to Alzheimer's disease.

Methods: The data are from Memories 2, "Changing the Trajectory of Mild Cognitive Impairment with CPAP Treatment of Obstructive Sleep Apnea." Participants had moderate to severe OSA, were CPAP naïve, and received a telehealth CPAP adherence intervention. Linear and logistic regression models examined predictors.

Results: The 174 participants (mean age 67.08 years, 80 female, 38 Black persons) had a mean apnea–hypopnea index of 34.78, and 73.6% were adherent, defined as an average of ≥4 hours of CPAP use per night. Only 18 (47.4%) Black persons were CPAP adherent. In linear models, White race, moderate OSA, and participation in the tailored CPAP adherence intervention were significantly associated with higher CPAP use at 3 months. In logistic models, White persons had 9.94 times the odds of adhering to CPAP compared to Black persons. Age, sex, ethnicity, education, body mass index, nighttime sleep duration, daytime sleepiness, and cognitive status were not significant predictors.

Conclusions: Older patients with aMCI have high CPAP adherence, suggesting that age and cognitive impairment should not be a barrier to prescribing CPAP. Research is needed to improve adherence in Black patients, perhaps through culturally tailored interventions.

Keywords: Motivational enhancement, Obstructive sleep apnea, Race, Tailored

Mild cognitive impairment (MCI) is defined as deficits in memory or other domains of cognition that do not significantly impact daily functioning (1). Persons with the amnestic type of MCI (aMCI), defined as MCI with memory complaints and deficits (1), have a high risk of progression to dementia, particularly due to Alzheimer's disease (2). An estimated

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58.7% of older adults with MCI also have obstructive sleep apnea (OSA) (3). OSA is characterized by repeated upper airway collapse and/or narrowing that can result in hypoxia and arousals (brief awakenings) from sleep, and impairments in memory, psychomotor speed, executive function, and other cognitive domains (4). The number of times per hour that the upper airway collapses and/or narrows is described as the apnea–hypopnea index (AHI). The severity of OSA is classified as: none/minimal AHI <5; mild ≥5; moderate ≥15, but <30; or severe >30 (5).

MCI is also prevalent in patients referred to sleep clinics for OSA. Beaudin et al. found that MCI, defined as a Montreal cognitive assessment test score of <26, was present in 47.9% of all patients referred to sleep clinics for OSA (n = 1 084) and >55% of patients with moderate to severe OSA (n = 560) (6). These findings were referenced in the American Thoracic Society's report on the link between OSA and cognitive decline (7).

Continuous positive airway pressure (CPAP) is the standard of practice for treating OSA (8). Pressurized air through a nasal mask is titrated to reduce the AHI, decrease arousals from sleep, and eliminate oxygen desaturation. Studies have shown that CPAP therapy increases stages N3 nonrapid eye movement sleep and rapid eye movement sleep, reduces daytime sleepiness, and improves blood pressure in hypertensive patients, but the effects on other outcomes such as long-term cardiovascular risk and neurocognitive function are inconsistent (9). If used as prescribed, CPAP is associated with significantly lowered odds of incident diagnosis of Alzheimer's disease and unspecified dementia (10) and improves 1-year cognitive function in older adults with aMCI (11), but CPAP initial and continued adherence (ie, the majority of patients with OSA require long-term CPAP treatment) are often suboptimal (3).

Factors likely to influence CPAP adherence in patients have been evaluated in a number of studies. In general, disease severity (higher AHI and lower oxygen desaturation) (3,12,13), higher levels of reported daytime sleepiness, and early adoption of CPAP (3,14) are consistently associated with increased long-term adherence to CPAP. Older research on how CPAP adherence varied by age has been mixed, but these past studies were often limited by small samples (15–17). In a recent study of telemonitoring data from 789 260 patients in a CPAP manufacturer database, overall adherence was 72.6%, but adherence varied dramatically by age and sex, ranging from 51.3% in 18- to 30-year-old women to 80.6% in 71- to 80-year-old men (18).

Other factors, such as higher body mass index (19), living as a couple (20,21), White race (22,23), and higher socioeconomic status (24) are often associated with higher CPAP adherence, but the evidence is modest. The most comprehensive evidence is for Black persons residing in the United States. In a systematic review, 16 of 22 studies showed significantly lower CPAP use for Black persons compared with White persons (22).

Patients with OSA may have comorbid insomnia. A systematic review and meta-analysis showed that 38% of patients with OSA meet insomnia diagnostic criteria (25,26). Insomnia is defined as frequent self-reported difficulties initiating sleep, maintaining sleep, and/or undesirable early morning awakenings from sleep that are associated with daytime impairment (27). Patients with both OSA and insomnia have lower average nightly use of CPAP therapy, compared to OSA alone (28,29).

Various interventions, such as education/supportive care, behavioral therapies, and patient engagement applications, have been evaluated in attempts to improve CPAP use. The evidence clearly supports the efficacy of behavioral interventions, such as motivational enhancement and cognitive behavioral therapy, but the efficacy of other interventions is unclear (9). A systematic review conducted by Askland et al. summarized and evaluated the evidence on the efficacy of behavioral interventions to improve CPAP use (30). They assessed the effect of educational, supportive, behavioral, or mixed (combination of 2 or more intervention types) strategies. When compared with usual care, behavioral interventions produce a clinically meaningful increase in device usage by 1.31 h/night (high-certainty evidence).

Although investigators have identified health outcomes associated with CPAP use, factors that affect CPAP use, and interventions that increase CPAP use, to our knowledge no one has prospectively examined predictors of CPAP adherence in a well-characterized, large sample of older adults with aMCI who have memory deficits that may affect their ability to use CPAP. The predictions can then be used by clinicians for planning and implementing therapeutic interventions for those at high risk for CPAP nonadherence, perhaps improving their adherence, and reducing the incidence of dementia. Our objective was to determine if demographics (age, sex, race, ethnicity, and education) and clinical factors (AHI, body mass index, nighttime sleep duration, daytime sleepiness, fidelity to a telehealth motivational enhancement CPAP adherence intervention, and cognitive status) predict 3-month CPAP adherence in older adults with aMCI and moderate to severe OSA.

Method

Study Design and Settings

We are conducting a quasi-experimental multisite study to determine the effects of CPAP adherence on cognitive function in older adults with moderate to severe OSA and aMCI. The primary outcome assessment is at 1 year (Clinical Trials.gov Identifier: NCT03113461). Accrual began in January 2018 and ended in November 2021. The end of follow-up is January 2023.

The University of Pennsylvania Central Institutional Review Board approved the research protocol for all sites—University of Pennsylvania, University of Texas at Austin, Washington University, and University of Virginia (Approval No. 828022). Written informed consent was obtained from all potential participants before any data were collected. We report here baseline data from the trial, fidelity data on the motivational enhancement telehealth CPAP adherence intervention, and CPAP use during the first 3 months of CPAP treatment.

Recruitment and Sample

Participants were recruited from sleep disorder centers, referrals from primary care, geriatric medicine, neurology and neuropsychology clinics, and community organizations or events, such as health fairs. Other sources were advertisements in community newsletters and on local radio, and flyers placed in businesses, such as barber shops. For sleep disorders centers, research staff reviewed sleep study interpretations, and patients who met the inclusion/exclusion criteria and had a documented memory complaint were identified and contacted by research staff. Interested participants were prescreened by telephone using the modified telephone interview for cognitive status (31). If prescreening was positive (telephone interview for cognitive status score ranging from 28 to

37 for English speakers and 26 to 37 for Spanish speakers), participants were invited for informed consent, followed by detailed cognitive testing for aMCI (32) and evaluation of the remaining criteria for study eligibility.

The inclusion criteria for Memories 2 are (a) aged ≥55–85 years; (b) moderate to severe OSA as defined by an AHI ≥15 events per hour, or no apnea as determined by diagnostic polysomnography or home sleep test; (c) clinical dementia rating scale score = 0–0.5 (33); (d) Mini-Mental State Examination score = 23–30 (34); (e) memory impairment as determined by scores on the logical memory II (1.0–1.5 standard deviations [*SD*s] below normal [adjusted for age and education]) (35); (f) stable for at least 4 weeks on medications (12 weeks for cholinesterase inhibitors/memantine); (g) nondepressed per geriatric depression scale score <6 (36); (h) has a study partner (caregiver/informant able to answer questions about the study participant); (i) adequate visual and auditory acuity for testing; (j) postmenopause or surgically sterile (females); (k) willing and able to complete baseline measures and provide CPAP adherence data; (l) at least 6 grades of education; and (m) fluent in English or Spanish.

Additional criteria for inclusion in the present analysis: (i) willing to try CPAP; (ii) had obtained a CPAP device through one of the following pathways: (a) ordered by the participant's sleep or primary care physician as part of their regular care, and covered by insurance; or (b) provided with a research Auto-CPAP device (ResMed AirSense AutoSet) by the Memories 2 project if participants did not have insurance or whose insurance copay for CPAP exceeded $250.

Exclusions for Memories 2: (a) significant neurologic disease other than aMCI; (b) psychiatric disorders such as schizophrenia or behavioral problems that could lead to difficulty complying with the protocol; (c) history of alcohol abuse or dependence within 6 months; (d) any current significant systemic illness that could affect testing such as unstable cardiovascular disease, current use of supplemental oxygen, daytime hypoxemia on room air, laboratory abnormalities such as untreated B12 deficiency or thyroid disease, and resident of a skilled nursing facility; (e) participation in clinical studies involving neuropsychological testing more than twice a year; (f) predominant central sleep apnea; and (g) adherence to CPAP or bilevel pressure for OSA within the past 6 months. Participants were not excluded if they reported a history of comorbid insomnia.

Measures

Demographic factors

Age, race, sex, ethnicity, education, and other demographic characteristics were self-reported by study participants.

Diagnostic polysomnography and home sleep tests

To determine their AHI, participants underwent full-night or split-night overnight diagnostic polysomnography as part of a clinical sleep assessment in an accredited sleep laboratory, or a 2-night diagnostic home sleep test, either as part of a clinical sleep assessment or the Memories 2 research protocol (ResMed ApneaLink Air Home Sleep Testing Device). Participants without insurance or whose insurance copay exceeded $250 qualified for a Memories 2 research home sleep test.

CPAP pressure

To determine their pressure settings, participants attended a laboratory titration study or an at-home auto-pressure adjustment using Automatic-Pap (APAP). A registered polysomnography technologist titrated the CPAP pressure during the clinical in-laboratory polysomnography. Settings for participants receiving either a clinical or research APAP machine were determined during unattended at-home use of the APAP unit as per clinical standards of practice (37). The device automatically titrated the pressure in response to changes in airway resistance. A sleep medicine physician reviewed the in-laboratory and home data and ordered the pressure settings, defined as one that normalized the AHI and eliminated snoring, desaturation, and arousals, and restored a normal flow contour.

Body mass index

Study research staff measured participant height and weight using a calibrated scale except during the coronavirus 2019 (COVID-19) pandemic lockdown. The lockdown began in March 2020 and ended when restrictions at each site were lifted in 2021. During the pandemic lockdown, study data were collected using virtual platforms, and height and weight were taken by research staff from medical records (if available), or self-reported by participants.

Nighttime sleep duration

Participants reported the usual minutes slept at night prior to starting CPAP on the study sleep history form.

Epworth Sleepiness Scale

The Epworth Sleepiness Scale is a chronic daytime sleepiness questionnaire containing 8 questions with responses on a 4-point scale (0–3) (38). The scale is reliable and internally consistent and bears relation to the severity of OSA. Scores range from 0 to 24 and a higher score is associated with increased sleepiness. Participants completed the scale prior to starting CPAP.

Fidelity to CPAP adherence intervention

All participants were provided with a tailored telehealth CPAP adherence intervention from trained research staff consisting of: (a) OSA education, treatment expectations, and methods to minimize barriers and facilitate CPAP use; (b) motivational enhancement to reinforce participants' health-related goals and CPAP self-efficacy (perceived confidence in one's ability to use CPAP), and to offer anticipatory guidance for common experiences with CPAP; and (c) social support by a study partner. Most support calls lasted 5–15 min, and emphasized an interactive dialogue. The intervention began the day before the first night of CPAP (Day 0) and continued on days 1, 2, 5, and 7; weeks 2, 3, and 4; 3 months; and every 3 months to follow until the study end. For this study, intervention fidelity was defined as the frequency of attendance (0–9). The intervention was adapted from the work of Aloia et al. (39), with tailored modifications for older adults with cognitive impairment such as the inclusion of a study partner and memory coaching on CPAP use processes. If participants decided to stop trying to use CPAP, research staff switched them to an attention control condition with the identical frequency and duration of phone contact.

Clinical Dementia Rating Scale Sum of Boxes

Trained research staff used semistructured interviewing of participants and study partners (informants) to rate participants using the CDR on six domains of cognitive functioning: memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care. They then obtained the Clinical Dementia Rating Scale Sum of Boxes (CDR-SOB) by summing each of the CDR domain scores (33). The CDR-SOB is a widely used, well-validated tool for staging cognitive functioning and tracking cognitive change. Scores range from 0 to 18, with scores 0.5–4.0 indicating questionable cognitive impairment (corresponding to CDR global score 0.5) and scores 16–18 indicating severe dementia (corresponding to CDR global score 3.0) (40).

CPAP adherence

Although CPAP reduces apneas and hypopneas associated with OSA, it must be consistently used for at least 4 h/night for a therapeutic response (41). CPAP systems precisely record and store CPAP use. Project staff downloaded the CPAP use data from the CPAP manufacturer's online platform or smartcard. Mean hours of CPAP use per night were calculated for each participant. Adherence was defined as mean CPAP usage ≥4 h/night during the first 3 months. Participants averaging <4 hours of CPAP use per night during the first 3 months were designated nonadherent.

Blinding

Those collecting predictors of CPAP adherence data were blind to CPAP adherence group. Cumulative CPAP use was abstracted from the CPAP manufacturer cloud database and double entered to ensure replicability.

Statistical Analysis

Descriptive statistics (means, *SD*s, medians, interquartile ranges, ranges, frequencies, and percentages) were generated to characterize this sample of 174 older adults with aMCI and moderate to severe OSA. Unadjusted and adjusted linear regression models were used to examine predictors of mean daily hours of CPAP use at 3 months. Similarly, unadjusted and adjusted logistic regression models were used to assess predictors of CPAP adherence versus not at 3 months. Additionally, backward elimination models for each outcome were also generated. According to this method, all variables demonstrating statistical significance at the 0.20 level in the unadjusted models were included in a single model for each outcome. Variables were then removed one at a time based on the largest p value until all predictors in the final model for each outcome demonstrated significance at the .05 level. Predictors of interest included baseline age, sex (male/female), race (White/Black/Other), ethnicity (Hispanic/non-Hispanic), education (>high school, ≤high school), AHI, body mass index, nighttime sleep duration, Epworth sleepiness scale, CPAP adherence intervention fidelity, and CDR-SOB. In unadjusted linear and logistic regression models, both continuous and dichotomous versions of AHI were used as a sole predictor, respectively, while in adjusted linear and logistic regression models, only dichotomous AHI (moderate, severe/very severe) was used. Due to missing data for CDR-SOB in 3 participants and for nighttime sleep duration in 10 participants, the sample size for analyses when including only CDR-SOB and only nighttime sleep duration was 171 and 164, respectively, and was 161 when analyses included both variables. As such, complete-case analysis was used to handle missing data. We did not analyze being an Asian person or another race because of small sample sizes. Collinearity in the adjusted linear model for CPAP use at 3 months was examined using the variance inflation factor (VIF), where a VIF of less than 10 for all variables is acceptable. Statistical significance was taken at the .05 level. All analyses were performed using SAS V9.4 (SAS Institute Inc., Cary, NC).

Sample Size

This is a secondary analysis of an ongoing study. As a general rule in logistic regression, at least 10 events per predictor variable are needed (42). Given our sample size (N = 174) and the number of nonevents (n = 46 CPAP nonadherent), we had sufficient power to detect four predictors of CPAP adherence.

Results

Figure 1 depicts how the sample was obtained from the Memories 2 trial data. Of the 174 participants, most were male (54%), White persons (71.3%), and non-Hispanic persons (92.5%), with a mean age of 67.08 years (*SD* 7.48) and mean CDR-SOB of 0.81 (*SD* 0.74). The Other category for race consisted of self-reported Asian, Native Hawaiian/Other Pacific, and Multiracial persons. The mean AHI was in the severe OSA range, with an average of 34.78 (*SD* 20.82) apneas/hypopneas per hour, and 46% of participants had severe OSA (AHI ≥30). The mean body mass index was 33.10 (*SD* 7.09), which falls into the obesity range. The average reported nighttime sleep duration was 7.41 hours (444.66 minutes, SD 85.69 minutes). Only 3 participants (2 CPAP-adherent, 1 CPAP nonadherent) reported an average nighttime sleep duration of less than 4 hours. Most did not report excessive daytime sleepiness (mean Epworth Sleepiness Scale = 8.89, *SD* 4.96), with 117 participants (67.24%) normal (score 0–10) (38). In general, participants attended most of the nine telehealth CPAP adherence intervention sessions that were offered to them. The mean attendance for the telehealth sessions was 6.59 (*SD* 1.39). For sample characteristics, please see Table 1.

Mean daily hours of CPAP use at 3 months was 5.15 hours (*SD* 2.50). A majority of participants, 128 (73.6%), were adherent to CPAP, maintaining an average of 4 or more hours of use per night. However, only 18 (47.4%) of Black persons were adherent compared to 101 (81.5%) of White persons (p < .001), and 9 (75%) of other persons (p < .001). Black persons (n = 38) mean daily hours of CPAP use was 3.87 (*SD* 2.47), compared to 5.58 (*SD* 2.39) in White persons (n = 124), p < .001, and 4.75 (*SD* 2.54) in Other persons (n = 12), p = .30 (Supplementary Table 1). Supplementary Tables 2 and 3 further describe CPAP use by apnea severity and CPAP adherence intervention fidelity by Race. Mean nightly CPAP use in the moderate group (AHI <30) was 5.67 hours (*SD* 2.39) compared to 4.55 hours (*SD* 2.52) in the severe group (AHI >30) (p = .001). There were no significant differences among Races in apnea severity or fidelity, although there was a trend for Black persons in the adherent group to attend fewer intervention sessions than Other persons (p = .06).

Adjusted linear model results demonstrated that being a White person (β = 2.01, *SE* = 0.50, p < .001), moderate (AHI <30) OSA (β = −1.17, *SE* = 0.36, p = .002), and higher CPAP adherence intervention fidelity (β = 0.38, *SE* = 0.13, p

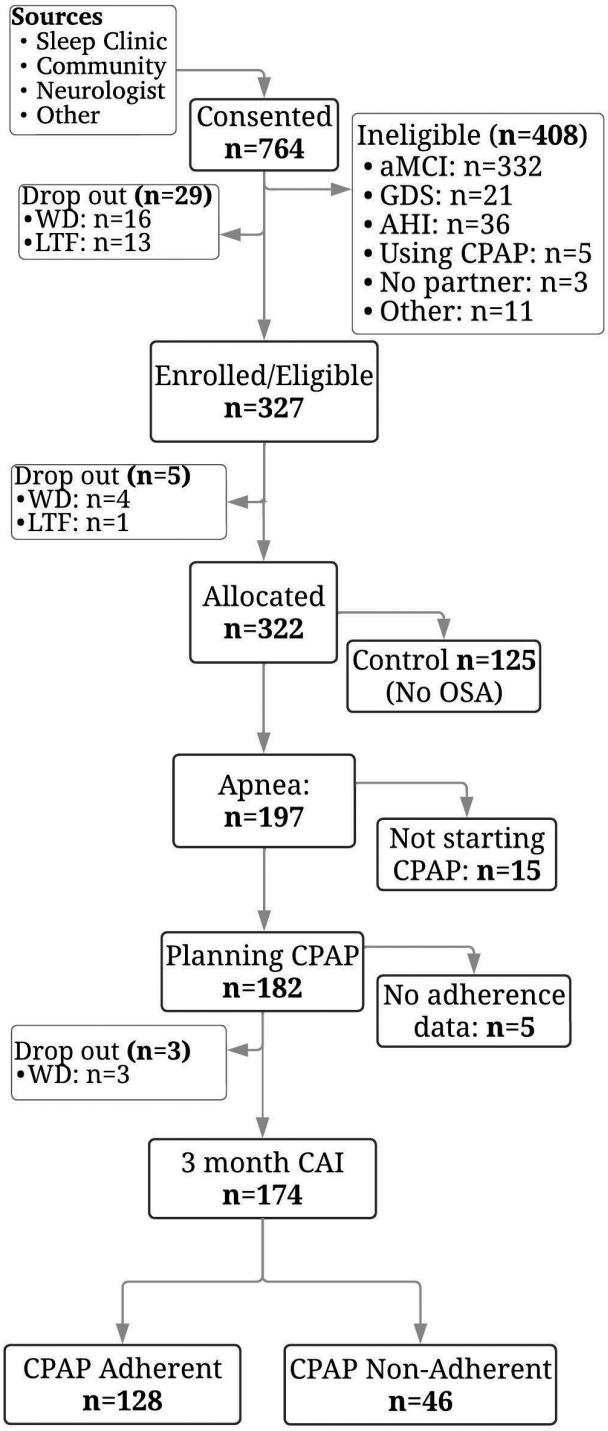

Figure 1. Consort diagram for Memories 2 Apnea Group. AHI = apnea–hypopnea index, aMCI = amnestic mild cognitive impairment, CAI = CPAP adherence intervention, CPAP = continuous positive airway pressure, GDS = geriatric depression scale, LTF = lost to follow-up, OSA = obstructive sleep apnea, PCP = primary care provider, WD = voluntary withdrawal.

= .004) were significantly associated with higher CPAP use at 3 months (Table 2). Age, sex, ethnicity, education, body mass index, nighttime sleep duration, Epworth sleepiness scale, and CDR-SOB were not statistically significant predictors. Using backward elimination methods, only being a White person (β = 1.57, *SE* = 0.43, $p < .001$), moderate OSA (β = −1.06, *SE* = 0.35, $p = .003$), and higher CPAP adherence intervention fidelity (β = 0.39, *SE* = 0.13, $p = .003$) were significantly associated with higher CPAP use (data not shown).

Unadjusted and adjusted logistic regression model results are summarized in Table 3. Adjusted logistic regression model results demonstrated that White race ($p < .001$) and higher CPAP adherence intervention fidelity ($p = .002$) were significantly associated with increased odds of CPAP adherence (≥4 hours mean CPAP use per night) at 3 months. Specifically, for every additional CPAP adherence intervention session attended, the odds of CPAP adherence increased by 58% (odds ratio [OR] = 1.58, 95% confidence interval [CI] = 1.18–2.11). Additionally, White persons compared with Black persons had 9.94-fold increased odds of adhering to CPAP treatment (OR = 9.94, 95% CI = 3.21–30.85). Age, sex, ethnicity, education, AHI, body mass index, nighttime sleep duration, Epworth sleepiness scale, and CDR-SOB were not statistically significant predictors. Using backward elimination methods, White race (OR = 4.66, 95% CI = 2.08–10.45, $p < .001$) and higher fidelity to the CPAP adherence intervention (OR = 1.46, 95% CI = 1.14–1.87, $p = .003$) were significantly associated with increased odds of adherence at 3 months (data not shown).

Discussion

To our knowledge, Memories 2 is the only large prospective study that has reported predictors of CPAP adherence in older adults with aMCI and moderate to severe OSA. Improving adherence in this population is an important goal, because consistent nightly use of CPAP in individuals with OSA results in improvements in daytime sleepiness, health-related quality of life, and depression, decreases risk for future cardiovascular events, and may affect the progression of cognitive impairment (41). Further, although few studies have been conducted on the outcomes of adherence to CPAP in older adults with aMCI and OSA, there may be a linear relationship between longer CPAP use and physiological benefits, as has been shown in studies of risk reduction for cardiovascular events (11,43).

In the Memories 2 study, almost 75% of this sample, all of whom are at high risk for progression to dementia due to Alzheimer's disease, adhered to CPAP for 3 months based on a cut-point of ≥4 h/night. Their average CPAP use was 5.15 ± 2.50 hours. This finding is notable, as other behavioral interventions that show evidence for improving cognition in this population, such as exercise, may be challenging to continue over time (43). The 1-year CPAP adherence for participants in the Memories 1 study ($n = 54$), who received the same telehealth CPAP adherence intervention as the present study, was 53.7%, with average use of 4.92 h/night (11).

In a recent pilot randomized controlled crossover study of CPAP treatment versus no treatment in 29 older adults with clinical MCI and OSA, the average CPAP use for patients in a typical clinical setting was somewhat less, 3.2 h/night (*SD* 2.8), although benefits in some domains of cognitive function occurred related to CPAP treatment (44). Skiba et al. found no relationship between CPAP therapy and progression to dementia over 2 years in a retrospective chart review of 96 patients (45). The average CPAP use was 3.9 h/night (45). Future trials in older adults with aMCI and OSA might compare CPAP adherence intervention strategies to determine which are most effective in this population of older adults with aMCI and OSA who are at high risk for dementia.

Table 1. Baseline Demographics and Descriptive Characteristics Memories 2 Apnea Group

Age (y)	Mean ± *SD*	67.08 ± 7.48
	Median (*Q*1, *Q*3)	67 (61, 72)
	Min, Max	55, 85
Sex, *n* (%)	Male	94 (54.0%)
Race, *n* (%)	White	124 (71.3%)
	Black	38 (21.8%)
	Other	12 (6.9%)
Ethnicity, *n* (%)	Hispanic	13 (7.5%)
Education, *n* (%)	>High school	138 (79.3%)
Apnea–hypopnea index	mean ± *SD*	34.78 ± 20.82
	median (*Q*1, *Q*3)	28.45 (19.50, 44.70)
	Min, Max	15, 119.4
Apnea–hypopnea index, *n* (%)	Moderate (<30)	94 (54.0%)
	Severe (≥30)	80 (46.0%)
Body mass index	mean ± *SD*	33.10 ± 7.09
	median (*Q*1, *Q*3)	32.02 (27.95, 36.30)
	Min, Max	20.12, 66.12
Nighttime sleep duration (min)	mean ± *SD*	444.66 ± 85.69
	median (*Q*1, *Q*3)	450.94 (399.34, 500.73)
	Min, Max	140, 740
Epworth sleepiness scale	mean ± *SD*	8.89 ± 4.96
	median (*Q*1, *Q*3)	8 (6, 12)
	Min, Max	0, 22
CAI fidelity	mean ± *SD*	6.59 ± 1.39
	median (*Q*1, *Q*3)	7 (6, 7)
	Min, Max	2, 8
CDR-SOB	mean ± *SD*	0.81 ± 0.74
	median (*Q*1, *Q*3)	0.5 (0, 1)
	Min, Max	0, 3.5
Mean daily CPAP use (h)	mean ± *SD*	5.15 ± 2.50
	median (*Q*1, *Q*3)	5.67 (3.8, 7.05)
	Min, Max	0, 9.3
3-Month CPAP use, *n* (%)	Adherent (mean ≥4 h)	128 (73.6%)
	Not adherent (mean <4 h)	46 (26.4%)

Notes: CAI = CPAP adherence intervention; CDR-SOB = clinical dementia rating sum of boxes; CPAP = continuous positive airway pressure; *SD* = standard deviation; *Q*1 = first quartile; *Q*3 = third quartile; due to 3 missing values, *N* = 171 for CDR-SOB. Due to 10 missing values, *N* = 164 for nighttime sleep duration; except for CDR-SOB and nighttime sleep duration, *N* = 174 for all other variables.

In this study, White race was a significant predictor of CPAP adherence in both linear and logistic models. Although a majority of study participants, 73.6%, were adherent to CPAP, only 18 (47.4%) of Black participants were adherent. Attendance at the adherence intervention sessions did not explain why Black persons were less likely to adhere to CPAP, as there were no significant differences among Black persons, White persons, or Other persons in the number of sessions attended. These findings regarding low CPAP adherence in Black persons are consistent with literature in other populations. In a recent review, 16 of 22 studies showed significantly lower CPAP use in Black persons compared with White persons (22). For example, in a younger sample with no mention of cognitive impairment, Billings et al. found that the mean CPAP use for 3 months was 267 minutes (*SD* 141) in White persons (*n* = 119) versus 179 minutes (*SD* 106) in Black persons (*n* = 42) (24). Future descriptive studies might focus on better understanding perceptions of Black persons regarding bias in clinical encounters, their health-related goals regarding OSA and memory, and their ideas about more effective adherence interventions. Lower CPAP use in Black persons may reflect health care inequities and distrust of medical professionals. In a nationally representative, probability-based survey of 802 non-Hispanic Black U.S. adults and a comparison group of 902 non-Hispanic White U.S. adults, about one third of Black persons reported experiencing discrimination in clinical encounters (46). These findings suggest a need for more active interventions to address racial implicit bias in clinical practice.

An additional strategy to address low CPAP adherence in Black persons is cultural tailoring of the adherence intervention. For example, Jean-Louis et al. developed and tested a culturally tailored telehealth intervention to increase the evaluation and treatment of OSA in Black persons (47). The investigators culturally tailored the intervention based on findings from focus groups. They then presented the intervention they

Table 2. Unadjusted and Adjusted Linear Model Results for Mean Daily CPAP Use (h)

Independent Variable	Unadjusted				Adjusted			
	Estimate	*SE*	95% CI	*p* Value	Estimate	*SE*	95% CI	*p* Value
Age	0.02	0.03	(−0.03, 0.07)	.44	−0.03	0.03	(−0.08, 0.02)	.28
Sex				.77				.39
Female	0.11	0.38	(−0.64, 0.87)		0.33	0.38	(−0.43, 1.09)	
Male	REF	REF	REF		REF	REF	REF	
Race				<.001				<.001
White	1.71	0.45	(0.83, 2.60)	<.001	2.01	0.50	(1.02, 2.99)	<.001
Other	0.88	0.80	(−0.70, 2.46)	.27	1.39	0.92	(−0.43, 3.20)	.13
Black	REF	REF	REF		REF	REF	REF	
Ethnicity				.99				.85
Hispanic	−0.01	0.72	(−1.44, 1.42)		0.16	0.87	(−1.56, 1.88)	
Non-Hispanic	REF	REF	REF		REF	REF	REF	
Education				.39				.87
> High School	0.41	0.47	(−0.52, 1.33)		0.08	0.47	(−0.85, 1.00)	
≤ High School	REF	REF	REF		REF	REF	REF	
Apnea–hypopnea Index	−0.01	0.01	(−0.03, 0.01)	.31				
Apnea–hypopnea Index				.003				.002
≥30	−1.12	0.37	(−1.85, −0.38)		−1.17	0.36	(−1.89, −0.46)	
<30	REF	REF	REF		REF	REF	REF	
Body mass index	−0.01	0.03	(−0.06, 0.04)	.67	0.02	0.03	(−0.03, 0.08)	.45
Nighttime sleep duration	0.00	0.00	(−0.00, 0.01)	.45	0.00	0.00	(−0.00, 0.01)	.39
Epworth sleepiness scale	−0.02	0.04	(−0.10, 0.05)	.53	0.01	0.04	(−0.07, 0.08)	.89
CAI fidelity	0.45	0.13	(0.19, 0.71)	<.001	0.38	0.13	(0.12, 0.64)	.004
CDR-SOB	−0.28	0.25	(−0.79, 0.22)	.27	−0.24	0.26	(−0.74, 0.27)	.36

Notes: CAI = CPAP adherence intervention; CDR-SOB = clinical dementia rating sum of boxes; CI = confidence interval; REF = reference; *SE* = standard error. For unadjusted model, *N* = 171 for CDR-SOB, *N* = 164 for nighttime sleep duration and *N* = 174 for all other variables; for adjusted model, *N* = 161.

derived to a subset of patients and their Community Steering Committee to ensure that the messaging was culturally sensitive, feasible, and acceptable. A trained sleep health educator of the same racial background delivered the intervention. In the randomized controlled trial (n = 380), those in the intervention arm were 3.17 times more likely to attend an initial sleep consultation visit, compared to an attention control group, but there was no difference in self-reported CPAP adherence between groups.

Investigators in future studies that aim to evaluate the effect of interventions to improve CPAP adherence in older Black persons with aMCI might consider testing the effect of a culturally tailored version (using the methods to develop the intervention described by Jean-Louis and colleagues) of the telehealth CPAP adherence intervention that we used in this study. Prior to beginning a future trial, it would be important that the interventionists receive training on implicit bias in clinical encounters, and demonstrate self-awareness of any biases and intervention competence during role playing. Also, in future CPAP adherence studies investigators might consider patient perception of discrimination in clinical encounters as an effect modifier.

In general, participants in the present study engaged in the CPAP adherence intervention. They attended more than 75% of the sessions. The telehealth intervention consisted of short phone sessions with trained research staff. The phone calls focused on motivational enhancement, individual goal setting, building self-efficacy, and guidance for any CPAP problems. The goal was that participants would identify the relationship between their personal goals and use of CPAP, and discover ways to overcome any perceived barriers to CPAP use.

In the present study, fidelity to the CPAP adherence intervention, as measured by the number of sessions attended, was significantly associated with CPAP use in both linear and logistic models. A recent systematic review identified 2 important mechanisms by which motivational enhancement could influence health behaviors: (1) motivation, defined as a client behavior that initiates, guides, and maintains goal-directed behavior, and (2) motivational interviewing spirit, defined as the key therapist behavior of collaboration and evoking client ideas about change and autonomy (48). These mechanisms have implications for clinicians. Our results add to the evidence that provider collaboration with patients and use of behavioral strategies to increase patient motivation are important for CPAP adherence (41). Perhaps patient motivation and self-efficacy beliefs moderate the relationship between treatment benefits deemed to be important by patients and CPAP adherence.

Those with moderate apnea (AHI 15–30) were significantly more likely to use CPAP longer each night than those with severe apnea (AHI ≥30). Other research has reported that a higher AHI is associated with longer CPAP use (3,12,13). Our findings may reflect dichotomizing the sample of older adults with aMCI into only 2 groups (moderate or severe apnea), or the homogeneity of the sample (eg, those with mild apnea were excluded).

Table 3. Unadjusted and Adjusted Logistic Model Results for 3-month CPAP Use (Adherent Vs Not Adherent)

Independent Variable	Unadjusted			Adjusted		
	Odds Ratio	95% CI	*p* Value	Odds Ratio	95% CI	*p* Value
Age	1.00	(0.95, 1.04)	.92	0.95	(0.89, 1.01)	.11
Sex			.77			.62
Female	0.90	(0.46, 1.78)		1.26	(0.51, 3.09)	
Male	REF	REF		REF	REF	
Race			<.001			<.001
White	4.88	(2.23, 10.66)	<.001	9.94	(3.21, 30.85)	<.001
Other	3.33	(0.78, 14.26)	.11	8.34	(0.99, 69.90)	.05
Black	REF	REF		REF	REF	
Ethnicity			.78			.54
Hispanic	1.21	(0.32, 4.62)		0.53	(0.07, 4.01)	
Non-Hispanic	REF	REF		REF	REF	
Education			.29			.69
>High School	1.53	(0.69, 3.38)		1.24	(0.43, 3.58)	
≤High School	REF	REF		REF	REF	
Apnea–hypopnea index	1.00	(0.98, 1.01)	.76			
Apnea–hypopnea index			.10			.08
≥30	0.56	(0.28, 1.11)		0.47	(0.20, 1.09)	
<30	REF	REF		REF	REF	
Body mass index	1.00	(0.96, 1.05)	.90	1.07	(0.99, 1.16)	.10
Nighttime sleep duration	1.00	(1.00, 1.00)	.90	1.00	(1.00, 1.01)	.93
Epworth sleepiness scale	0.99	(0.93, 1.06)	.83	1.03	(0.94, 1.12)	.58
CAI fidelity	1.49	(1.17, 1.88)	.001	1.58	(1.18, 2.11)	.002
CDR-SOB	0.77	(0.49, 1.21)	.25	0.86	(0.48, 1.54)	.61

Notes: CAI = CPAP adherence intervention; CDR-SOB = clinical dementia rating sum of boxes; CI = confidence interval; CPAP = continuous positive airway pressure; REF = reference. Adherent = average of 4 or more hours of CPAP use per night; not adherent = average of less than 4 hours of CPAP use per night. For unadjusted model, $N = 171$ for CDR-SOB, $N = 164$ for nighttime sleep duration, and $N = 174$ for all other variables; for adjusted model, $N = 161$.

The finding that age was not significantly associated with CPAP adherence provides evidence that older adults with aMCI can successfully use CPAP into their 80s, a positive finding. There were only 13 Hispanic persons in the study, which may have been an insufficient sample to show relationships between ethnicity and CPAP adherence. Similarly, there were only 12 participants of Other race which limited the ability to identify relationships between Other race and CPAP adherence. Due to participants choosing not to report their incomes, education (high school or higher vs less than high school) was used as a proxy for socioeconomic status. More comprehensive measures of socioeconomic status might yield different results.

There was no relationship between CPAP use and cognition as measured by CDR-SOB. Although our results may reflect the lack of cognitive variability in the sample, Ancoli-Israel et al. also found similar CPAP use (5.8 h/night) in a sample of older adults with probable mild AD (49). Taken together, our findings and those of Ancoli-Israel and colleagues are encouraging because they indicate that both older adults with aMCI and mild dementia are cognitively able to use CPAP.

Strengths of this study include a large, diverse sample of females, Black persons, and Hispanic persons; objective CPAP adherence data; a comprehensive telehealth motivational enhancement CPAP adherence intervention; and both linear and logistic regression modeling. There are also limitations. Conclusions regarding factors not statistically associated with adherence may reflect the relatively small sample size. There may have been insufficient power to observe more modest associations. Although the Memories 2 study MCI diagnostic criteria mirrored those of the Alzheimer's Disease Neuroimaging Initiative 2 (35) and were similar to other large studies on MCI (50), we recognize that using a single measure of episodic memory to diagnose MCI, and including participants with early MCI may increase susceptibility to false positive diagnostic errors.

Conclusions and Relevance

Older adults with aMCI can have high levels of CPAP adherence, suggesting that neither age nor cognitive impairment should be a barrier to prescribing CPAP. Research is needed to improve CPAP adherence in Black patients. Motivational enhancement interventions that are developed with the help of the population of interest, and delivered by trained educators of the same racial background may improve CPAP adherence and health in older Black persons with aMCI and apnea.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

K.C. R. has received Horizant and placebo from Arbor Pharmaceuticals, and consulting fees from Merck and Woolsey Pharmaceuticals, Inc. D.A.W. has received grant support from Biogen and Merck, serves on the Data Safety Monitoring Board for Functional Neuromodulation, and has received consulting fees from Eli Lilly, GE Healthcare, and Qynapse.

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Data Availability

Data will be shared with others upon request through the Memories 2 website https://www.med.upenn.edu/memories2/researcher-welcome.html no later than July 1, 2026.

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