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Sleep Disturbances and Driving Practices Among Older Drivers

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Abstract

OBJECTIVES—To evaluate the associations between sleep disturbances and driving practices, including driving cessation and trajectories of daily driving mileage (i.e. change over time), among older drivers.

DESIGN—Longitudinal.

SETTING—New Haven, Connecticut.

PARTICIPANTS—430 older drivers, mean age 78.5, recruited from clinic and community sites.

MEASUREMENTS—Baseline measures included medical history, daily driving mileage, Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS), and Sleep Apnea Clinical Score (SACS). Longitudinal outcomes included at least one episode of driving cessation and trajectories of miles driven per day, as recorded every 6-months over 2-years.

RESULTS—At baseline, participants drove an average of 22.2 miles/day; 26.0% (112/430) had insomnia (ISI≥8), 19.3% (83/430) had daytime drowsiness (ESS≥10), and 19.9% (84/422) had high sleep apnea risk (SACS>15). Regarding driving cessation, the sleep-based predictors of insomnia, daytime drowsiness, and high sleep apnea risk did not confer a significantly increased risk; risk ratios (95% confidence interval) were 1.20 (0.65, 2.20), 0.94 (0.46, 1.95), and 0.62 (0.27, 1.42), respectively. Regarding driving mileage, insomnia was the only sleep-based predictor that conferred a significant change, yielding an average decrease of 4.5 miles/day over 2-years (p=0.01). In the insomnia model, covariates that were associated with decreased driving mileage included polypharmacy (≥4 medications) and each year of additional age, yielding an average decrease of 8.3 (p=0.01) and 0.4 miles/day (p=0.02), respectively, over 2-years.

CONCLUSION—In our cohort of older drivers, insomnia and the covariates of polypharmacy and advancing age were longitudinally associated with decreased daily driving mileage. Because reductions in driving mileage among older persons often occur in response to reductions in driving capacity, these results support a clinical approach that considers insomnia-based cognitive-behavioral therapy and reduced polypharmacy as strategies for improving driving capacity among older persons.

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Keywords

Insomnia; daytime drowsiness; sleep apnea; older drivers

INTRODUCTION

In 2008, there were more than 21 million licensed drivers aged ≥70 in the United States, a number that will continue to rise with an aging population.[1] Because advancing age is associated with cognitive, visual, and physical impairments, reductions in driving capacity are likely to develop in older persons.[2–8] Surprisingly, despite high prevalence rates,[9–11] sleep disturbances have not been evaluated as risk factors for reduced driving capacity in older age.[3–8] This is, perhaps, because rates of drowsy-driving are low in persons aged ≥65, with only 4–6% having "dozed-off" while driving, versus 20–27% of all drivers.[10,12,13]

The age-related discordance between high rates of sleep disturbances but low rates of drowsy-driving could be explained in at least two ways. First, older persons who have sleep disturbances stop driving, whereas those who continue to drive do not have a sleep disturbance. This is unlikely because prior work has shown that a substantial proportion of older drivers have sleep disturbances, including insomnia, daytime drowsiness, and high sleep apnea risk.[14] This prior work was cross-sectional, however, and thus it remains uncertain as to whether sleep disturbances are associated longitudinally with driving cessation. Second, older drivers who have sleep disturbances may not experience drowsy-driving because they change their driving practices. This merits consideration because prior work has shown that older drivers on their own initiative compensate for reductions in driving capacity by avoiding high-risk settings such as peak-traffic times and night-time, or by driving shorter distances.[4,14–19] Whether sleep disturbances could also lead to a similar change in driving practices has not yet been reported. In particular, driving shorter distances and avoiding night-time driving (i.e. reduced circadian alertness) would likely attenuate the adverse effects of sleep disturbances on driver alertness.

In the present study, we set out to evaluate the longitudinal association between sleep disturbances and driving practices in a cohort of older drivers. Specifically, using validated sleep and driving questionnaires, we evaluated the association between baseline sleep disturbances and subsequent driving cessation, as recorded at 6-month intervals over a span of 2-years. In addition, using group-based latent class trajectory and linear mixed effects models, we evaluated the association between baseline sleep disturbances and miles driven per day over time, also recorded at 6-month intervals over a span of 2-years. We postulated that sleep disturbances may lead to driving cessation or a decline in daily driving mileage. If confirmed, because they are potentially modifiable,[11] the management of sleep disturbances could extend driving life in older persons and, in turn, potentially mitigate the social isolation and depressive symptoms that can accompany driving cessation or reduction.[20,21]

METHODS

Study Population

Older drivers were recruited for an on-road driving evaluation from clinic and community sites in greater New Haven, Connecticut. The majority of participants (86%) were from the Veterans Administration Connecticut Healthcare System (VA). Eligibility criteria included age ≥70, telephone access, English-speaking, community-living, and currently having a license and driving at least once-a-week. Exclusion criteria included substantial cognitive or vision impairments, defined by a Mini-Mental State Examination (MMSE)[22] score <18 and distance vision <20/70, respectively. Of the 645 participants screened, 496 met eligibility

criteria, with 430 also administered sleep questionnaires (sleep instruments were a late addition). Relative to those enrolled in the sleep component of this project, eligible individuals who did not participate had a similar age and were also predominantly male. The Yale and VA Human Investigation Committees approved the study protocol and all participants gave written informed consent.

Demographic and Clinical Characteristics

Baseline data included age, gender, race, marital status, education, chronic conditions, health status, cognition, depression, medications, driving mileage (miles/day), and frequency of night-time driving. Cognition was evaluated by the MMSE, with an abnormal score being <24.[22] Depression was assessed by the Center for Epidemiologic Studies Depression Scale (CES-D), with a score ≥16 indicating substantial depressive symptoms.[23] Medications were categorized as the total number of prescription and non-prescription medications and whether participants used ≥4 medications or a medication with central nervous system (CNS) effects (benzodiazepines, barbiturates, opiates, antihistamines, antipsychotics, antidepressants, anticonvulsants, or muscle relaxants). Among older persons, the use of ≥4 medications has clinical relevance, given its association with reduced physical performance (impaired balance and falls) and delirium.[24–26] Moreover, a prior clinical trial has shown that a reduction in falls is associated with using <4 medications.[25] Lastly, based on self-reported driving frequency, the avoidance of night-time driving was defined as driving at night less than 4 times per month.

Sleep Questionnaires

We administered validated sleep questionnaires at baseline—Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS), and Sleep Apnea Clinical Score (SACS). The ISI is a 7-item questionnaire based on criteria from the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV).[27] An ISI≥8 established a diagnosis of insomnia, with higher scores signifying more severe symptoms.[27]

The ESS measures the chance of dozing during eight different activities, with higher scores signifying more severe symptoms.[28] Although lacking rigorous validation, two cited thresholds for the ESS are 10 and 11.[28–32] To establish clinically-meaningful daytime drowsiness, we opted for an ESS≥10, because this was previously used by the National Sleep Foundation in surveys of driving practices and, among older persons, is associated with hypertension, stroke, frailty, and lower self-reported driving capacity.[14,29–32] Based on a single-item from the ESS, we also identified drowsy-driving if participants reported any chance of dozing when “in a car, while stopped for a few minutes in traffic.”[28]

The SACS instrument is used to assess clinical risk for obstructive sleep apnea (OSA), based on neck-circumference, hypertension, snoring, and partner-reported apneas.[33] Relative to a reference group having laboratory-confirmed OSA, a SACS<5 confers low risk for OSA, whereas a SACS≥15 indicates high-risk for OSA.[33] SACS values of 5–15 are indeterminate.[33] In our protocol, because aging is associated with living alone (no bed partner),[34] we modified the SACS to include self-reported nocturnal-choking or -gasping.

Outcomes

The outcomes of interest included driving cessation and miles driven per day, ascertained by telephone interviews every six months over a span of 2-years. The driving cessation variable referred to the first episode that was recorded during the 6-month follow-up interviews. Of the 430 study participants, 381 (88.6%) had complete follow-up, 40 (9.3%) had partial follow-up, and 9 had no follow-up. Reasons for termination included death (22), refusal/unable to contact (11), unable due to illness (8), stopped driving (7), and failed road test (1).

Among the 421 who had complete or partial follow-up, the status of driving cessation could be determined in 394, of whom 44 (11.2%) reported at least one episode of driving cessation; the remaining 27 had partial follow-up and were actively driving at the time of the last interview.

Statistical Analysis

The baseline characteristics of the participants were first described as counts accompanied by percentages or as means accompanied by standard deviations (± SD). Next, driving cessation was cross-tabulated with the baseline sleep disturbance variables, yielding risk ratios as unadjusted measures of association. The binary sleep disturbance variables included insomnia (ISI≥8), daytime drowsiness (ESS≥10), and high sleep apnea risk (SACS>15), with absence of the corresponding sleep disturbance as referent groups.

To understand driving practices over time, group-based finite mixture regression modeling was used to identify groups of individuals having similar trajectories in daily driving mileage.[35] This analysis identified latent classes or subgroups of participants who had similar trajectories of daily driving mileage over time and estimated a mean trajectory for each subgroup. The number of subgroups identified and the number of higher-order terms used in the model were determined by the data, using an overall Bayesian Information Criterion and p values for individual model parameters as measures of goodness of fit.

Upon identifying subgroups of participants with similar driving trajectories, the subgroups were then cross-tabulated with baseline characteristics to obtain clinical profiles. Results of the group trajectory analysis provided useful information for deciding how best to fit multivariable models for investigating associations over time of sleep disturbance variables with the daily driving mileage outcome.[36]

The relatively large size of one driving trajectory group (see Figure) motivated the use of linear mixed effects models, because these use random effects to model departures from a single conditional mean outcome. Linear mixed models account for the serial correlation in repeated measurements over time, and accommodate data missing at random in a model with relevant covariates. Random effects pattern mixture models[37] investigated the nature of missing values in the longitudinal dataset, with missing data indicator variables from cross-sectional models used to identify variables possibly accounting for missing data. Clinically-plausible interaction terms were entered into the model, and removed if not significant. Residual analysis and influence diagnostics assessed model fit.

SAS version 9.2 was used for all analyses,[38] with $p < 0.05$ in two-sided tests reported as significant. R software (version 2.14.2) was used to create the group trajectory plots.[39]

RESULTS

Table 1 shows baseline characteristics of participants. The mean age was 78.5; 84.9% (365/430) were male, 95.1% (409/430) were white, 56.7% (244/430) were married, and education averaged 13.2 years. The mean number of chronic conditions was 3.4, with fair-to-poor health status reported by 25.8% (111/430). The mean scores for MMSE and CES-D were 27.6, and 7.1, respectively—2.3% (10/430) had MMSE <24 and 13.0% (56/430) had CES-D ≥16, respectively. Participants averaged 7.7 medications—91.9% (395/430) used ≥4 medications and 14.0% (60/430) reported the use of a CNS-medication.

Table 1 also shows the baseline sleep and driving characteristics of participants. Sleep questionnaires yielded mean scores for ISI, ESS, and SACS of 4.7, 6.0, and 10.2, respectively. Sleep disturbances in the form of insomnia (ISI≥8) occurred in 26.0%

(112/430), daytime drowsiness (ESS≥10) in 19.3% (83/430), and high sleep apnea risk (SACS>15) in 19.9% (84/422). Driving averaged 22.2 miles/day—5.1% (22/394) reported drowsy-driving and 30.7% (132/430) avoided night-time driving.

Table 2 shows risk ratios for at least one episode of driving cessation according to baseline sleep disturbance, as recorded at the 6-month interviews and over a span of 2-years. As can be seen, insomnia, daytime drowsiness, and high sleep apnea risk were not significantly associated with driving cessation—unadjusted risk ratios (95% confidence interval) of 1.20 (0.65, 2.20), 0.94 (0.46, 1.95), and 0.62 (0.27, 1.42), respectively.

The Figure shows latent class trajectories of daily driving mileage, as recorded at the 6-month interviews and over a span of 2-years. Three different patterns over time were identified, including low, medium, and high average driving mileage groups (groups 1, 2, and 3, respectively)—representing 87% (376/430), 10% (42/430), and 3% (12/430) of study participants, respectively. The majority of participants had stable driving trajectories. The characteristics of each of these three mileage groups are shown in Table 3. On average, there were modest differences in characteristics amongst the low, medium, and high average driving mileage groups (groups 1, 2, and 3, respectively), with the more substantive being the frequency of CNS-medication use (14.6%, 9.5%, and 8.3%, respectively) and insomnia diagnosis (27.4%, 19.0%, and 8.3%, respectively), as well as mean ISI scores (5.0, 3.6, and 1.8, respectively).

Table 4 shows regression estimates for selected predictor variables in the insomnia model, indicating average change in daily driving mileage over 2-years (i.e. for each one-step increment in the value of the predictor variable). As can be seen, only four variables were significantly associated with daily driving mileage, namely insomnia (p=0.01), polypharmacy (≥4 medications, p=0.01), age (each year of additional age, p=0.02), and male gender (p=0.01). Specifically, insomnia estimated an average decrease in driving of 4.5 miles/day over 2-years, yielding a 19.0 % difference (−4.5/23.7) relative to the group without insomnia. Polypharmacy estimated an average decrease in driving of 8.1 miles/day over 2-years, yielding a 32.4% difference relative to <4 medications (−8.3/25.6). In contrast, male gender estimated an average increase in driving of 6.1 miles/day over 2-years, yielding a 33.2% difference (+6.1/18.4) relative to female gender. Otherwise, neither daytime drowsiness or high sleep apnea risk were significantly associated with daily driving mileage (results not shown).

DISCUSSION

In a cohort of older drivers and over 2-years of follow-up, we found that baseline daytime drowsiness (ESS≥10) and high sleep apnea risk (SACS>15) were not longitudinally associated with driving cessation or daily driving mileage. Although also not associated with driving cessation, we found that baseline insomnia (ISI≥8) was nonetheless longitudinally associated with daily driving mileage, conferring an average decrease of 4.5 miles/day over 2-years. In the insomnia model, covariates that were associated with decreased daily driving mileage included polypharmacy (≥4 medications) and each year of additional age, conferring an average decrease of 8.3 and 0.4 miles/day, respectively, over 2-years. In contrast, the only covariate that conferred an increase in daily driving mileage was male gender, averaging 6.1 miles/day over 2-years. Lastly, we found that 87% of our cohort drove <20 miles/day, and that this lower-mileage group had higher frequencies of insomnia and polypharmacy, as well as a higher ISI score, than the higher-mileage groups.

The results of the present study suggest that driving practices in older persons may be altered by insomnia, given its longitudinal association with a decrease in daily driving

mileage. The mechanisms that underlie this association are not known but may relate to the adverse effects of non-restorative sleep (insomnia) on daytime function. For example, the daytime consequences of insomnia can include excessive worry, increased irritability and fatigability, and impaired cognition (memory and executive functioning).[40] These are likely to progress over a day's prolonged period of wakefulness, particularly if the insomnia is characterized by early morning awakenings.[40,41] As shown in our prior work[14] and the present study, nearly one-third of older drivers reported early morning awakenings, while another one-third avoided night-time driving, respectively. Moreover, our prior work[14] has also shown that insomnia was cross-sectionally associated with a lower self-rating for night-time driving, but not for daytime driving.

In the insomnia model, polypharmacy and age were longitudinally associated with a decrease in daily driving mileage. It is well established that medication- and age-related adverse effects include reductions in physical and neurocognitive function, and these, in turn, may lead to both insomnia and reduced driving capacity.[2–1124–26,42–45] Moreover, because the use of a CNS medication was not itself a significant predictor in our insomnia model, we hypothesize that the adverse effects of polypharmacy may additionally result from drug interactions, including the cumulative effect of anticholinergic burden.[24–26,42–45]

Surprisingly, in the insomnia model, the number of chronic conditions was not associated with a decrease in daily driving mileage. This is unexpected because insomnia is often comorbid, particularly among older persons, and frequently co-exists with arthritis, neuropsychological impairments, diabetes mellitus, and cardiopulmonary diseases.[11,46] These health conditions are not only disruptive to sleep, but can also contribute to reduced driving capacity.[2–8,11] Consequently, we hypothesize that the polypharmacy variable may additionally represent the effects of a high medical burden, because multimorbidity often results in complex prescribing patterns and increases the risk of medication-related adverse events.[24–26,47, 48]

Because reductions in driving mileage among older persons often occur in response to reductions in driving capacity,[4,14–19] the results of the present study support a clinical approach that considers insomnia therapy and reduced polypharmacy as potential strategies to improve driving capacity among older persons.[11,25,49,50] This clinical approach may also mitigate the social isolation and depressive symptoms that can complicate the course of insomnia and reduced driving capacity.[11,20,21] Regarding insomnia therapy, the emphasis is on cognitivebehavioral interventions, rather than hypnotics.[11,49,50] Regarding polypharmacy, effective medication reduction may be achieved by implementing non-pharmacologic interventions for comorbidities, including promoting healthy lifestyles through increased physical activity, dietary interventions, and improved socialization.[11]

Otherwise, the benefits of insomnia therapy on driving safety may be limited. In the same cohort of older drivers, we have previously shown that insomnia is not longitudinally associated with adverse driving events (crash, traffic-infraction, near-crash, or getting lost).[15] This lack of association may reflect a reduced exposure to driving risk that is unique to older drivers. For example, other investigators have shown that persons aged 30–34 drive 42.3 miles/day, whereas those aged 75–79 drive only 13.8 miles/day.[51] Our cohort of older drivers similarly reported shorter distances, with the largest subgroup of drivers averaging <20 miles/day (i.e. group 1). The exposure to driving risk may be additionally reduced by avoiding night-time driving,[18] yielding two potential benefits; first, it avoids the adverse effects of age-related visual impairments on night-time driving (e.g. glare of oncoming headlights) and, second, it avoids the circadian reduction in night-time alertness.[11,41] As noted earlier, nearly one-third of our older drivers avoided night-time driving.

Alternatively, a gender effect may have modified the association of insomnia with daily driving mileage, driving cessation, and adverse driving events. In general, older women are more likely than older men to have insomnia and self-regulate driving.[11,17,52] In our cohort of older drivers, male gender was associated with increased daily driving mileage, relative to female gender. However, because our cohort of older drivers was predominantly male, it was not suitable for investigating gender as an effect modifier.

Although well established as risk factors for decreased driving capacity in the general population,[53–55] the present study and our prior work[15] have not provided evidence for an association of daytime drowsiness and high sleep apnea risk with driving cessation, daily driving mileage, or adverse driving events, among older drivers. Age-related factors may be responsible. For example, using the same ESS threshold, a national survey of drivers aged 18–29 reported prevalence rates for daytime drowsiness (41.7%) and drowsy-driving (19.4%) that were higher than our cohort of older drivers (19.0% and 5.1%, respectively).[29] These age-related differences may arise via three mechanisms. First, chronic sleep loss and the consequent reduction in performance across wakefulness is more prevalent and severe in younger than older persons.[29,56–58] Second, the importance of obstructive sleep apnea (OSA) may diminish with age. For instance, OSA is associated with more severe hypoxemia in younger than older persons, and OSA is associated with an increased risk of incident coronary heart disease in middle-age but not in old-age.[59,60] Third, as discussed earlier, younger persons drive longer distances than older drivers—in general, longer driving distances are associated with drowsy-driving.[61] Nonetheless, regardless of age, drivers who specifically report daytime drowsiness, especially drowsy driving, should be evaluated for breathing and non-breathing forms of hypersomnia (e.g. sleep apnea and medication-related hypersomnia, respectively).

We recognize several potential limitations to our study design. First, we used sleep instruments that are based on self-report. Because aging is associated with reduced symptom-awareness,[62] the ISI and ESS may be limited as an indicator of sleep disturbances in older persons. Moreover, prior work has also shown that self-reported snoring and apneas have diminished predictive capacity for OSA in older persons, thereby potentially limiting the accuracy of the SACS instrument.[63] Second, we have used reduced driving mileage as a surrogate measure for reduced driving capacity. Although this is a frequent approach when surveying driving practices in older persons,[19] the reduction in daily driving mileage may be also related to social factors (i.e. retirement), rather than reduced capacity to operate a motor vehicle. Third, as discussed earlier, our cohort was predominantly male. Fourth, our sample size was powered to detect significant differences only at a risk ratio greater than 2.0. Lastly, because we included only active older drivers (at study entry) and limited our subsequent follow-up to 24 months, these two factors may have attenuated the associations between sleep disturbances and driving outcomes. Hence, to more definitively assess the impact of sleep disturbances on driving outcomes, future studies will need to enroll a larger sample of older persons, including former and current drivers, represent women more fully, objectively evaluate sleep disturbances and driver performance, and provide longer follow-up.[64–66] (Evaluation of former drivers may further inform the association between sleep disturbances and driving cessation.)

In conclusion, in a cohort of older drivers, we found that insomnia and the covariates of polypharmacy and advancing age were longitudinally associated with decreased daily driving mileage. Because reductions in driving mileage among older persons often occur in response to reductions in driving capacity,[19] these results support a clinical approach that considers insomnia-based cognitive-behavioral therapy and reduced polypharmacy as a potential strategy for improving driving capacity among older persons.

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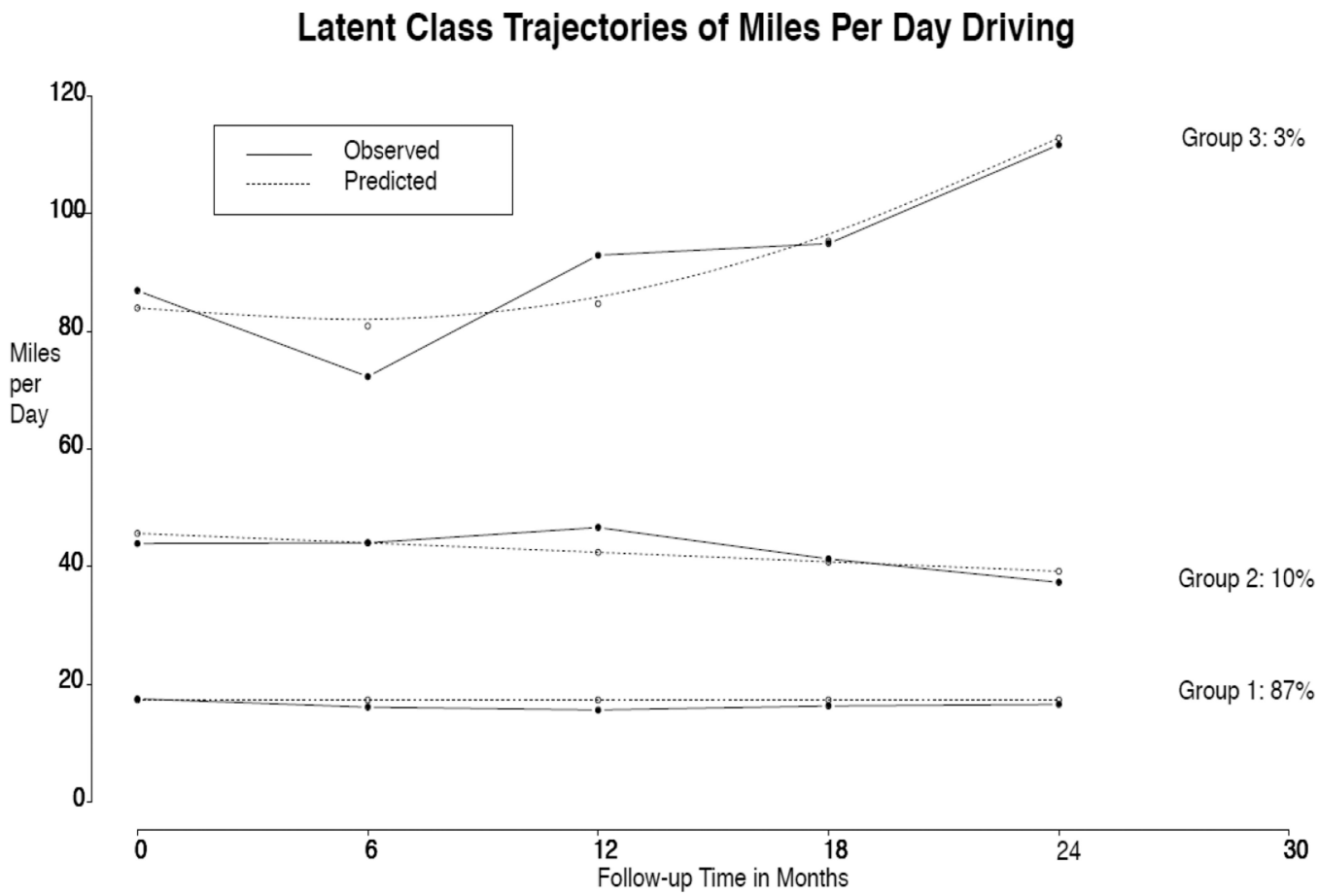

Figure. Latent class trajectory groups of miles driven per day, as recorded at the 6-month follow-up interviews and over the span of 2-years (N = 430)

The solid dots represent observed averages; the open dots represent predicted points; and the dashed lines between them represent smoothed splines.

Table 1

Baseline characteristics of study participants

Characteristic	All N = 430
Age (years), mean (± SD)	78.5 (± 4.9)
Male, No. (%)	365 (84.9)
White, No. (%)	409 (95.1)
Married, No. (%)	244 (56.7)
Education (years), mean (± SD)	13.2 (± 2.7)
Chronic conditions, mean (± SD)	3.4 (± 1.9)
Chronic Conditions >2, No. (%)	286 (66.5)
Fair-to-poor health status, No. (%)	111 (25.8)
MMSE score, mean (± SD)	27.6 (± 1.9)
MMSE <24, No. (%)	10 (2.3)
CES-D score, mean (± SD)	7.1 (± 7.7)
CES-D ≥16, No. (%)	56 (13.0)
Medications	
Number used, mean (± SD)	7.7 (± 3.8)
Medications ≥4, No. (%)	395 (91.9)
CNS-medication use, No. (%) [a]	60 (14.0)
Sleep questionnaire scores, mean (± SD)	
Insomnia severity index (ISI)	4.7 (± 5.0)
Epworth sleepiness scale (ESS)	6.0 (± 3.7)
Sleep apnea clinical score (SACS) [b]	10.2 (± 10.2)
Sleep disturbances, No. (%)	
Insomnia (ISI≥8)	112 (26.0%)
Daytime drowsiness (ESS≥10)	83 (19.3%)
High sleep apnea risk (SACS>15)	84 (19.9%)
Driving	
Driving mileage (miles/day), mean (± SD)[c]	22.2 (± 21.1)
Drowsy driving, No. (%) [d]	22 (5.1)
Avoided night-time driving, No. (%) [e]	132 (30.7)

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; CNS, central nervous system; MMSE, MiniMental State Examination; SD, standard deviation.

[a] Includes benzodiazepines, barbiturates, opiates, antihistamine, antipsychotics, antidepressants, anticonvulsants, or muscle relaxants.

[b] Based on N=422, due to 8 missing data for SACS.

[c] There is one missing value for this variable.

[d] Defined as a chance of dozing when “in a car, while stopped for a few minutes in traffic.”

[e] Defined as driving at night less than 4 times per month.

Table 2

Risk ratios for having at least one episode of driving cessation, according to baseline sleep disturbance

Sleep Disturbance	No. (%) [a]	No. (%) of participants with driving cessation [b]	Driving Cessation [c] Risk Ratios (95% Confidence Interval)
Inia Severity Index (N = 394) [d]			
<8 (no insomnia)	292 (74.1)	31 (10.6)	1.00
≥8 (insomnia)	102 (25.9)	13 (12.7)	1.20 (0.65, 2.20)
Epworth Sleepiness Scale (N = 394) [d]			
<10 (no drowsiness)	319 (81.0)	36 (11.3)	1.00
≥10 (daytime drowsiness)	75 (19.0)	8 (10.7)	0.94 (0.46, 1.95)
Sleep Apnea Clinical Score (N = 386) [e]			
<5 (low sleep apnea risk)	308 (79.8)	38 (12.3)	1.00
≥15 (high sleep apnea risk)	78 (20.2)	6 (7.7)	0.62 (0.27, 1.42)

Abbreviations: CI, confidence interval

[a] Column percent .

[b] Row percent.

[c] Defined as the first episode of driving cessation as recorded at the 6-month follow-up interviews and over the span of 2-years.

[d] Of the 430 participants, 27 were excluded because of partial follow-up with no driving cessation reported and 9 were excluded because of no follow-up, yielding 394 participants.

[e] Of the 394 participants described above, 8 were excluded because of missing data for SACS, yielding 386 participants.

Table 3

Characteristics of latent class trajectory groups according to miles driven per day

Baseline Characteristics	Trajectory Groups Miles Driven per Day		
	Group 1: Low (N=376)	Group 2: Medium (N=42)	Group 3: High (N=12)
Age (in years), mean (± SD)	78.5 (± 4.9)	78.5 (± 4.8)	77.4 (± 4.7)
Male, No. (%)	314 (83.5)	39 (92.9)	12 (100)
Non-White, No. (%)	20 (5.3)	1 (2.4)	0 (0.0)
Education (years), mean (± SD)	13.1 (± 2.7)	13.1 (± 2.6)	13.7 (± 2.2)
Married, No. (%)	210 (55.9)	26 (61.9)	8 (66.7)
Chronic conditions, mean number (± SD)	3.4 (± 1.9)	3.5 (± 1.7)	3.3 (± 1.8)
Chronic conditions >2, No. (%)	245 (65.2)	32 (76.2)	9 (75.0)
MMSE score, mean (± SD)	27.6 (± 1.9)	27.5 (± 2.0)	27.6 (± 2.3)
MMSE <24, No. (%)	7 (1.9)	2 (4.8)	1 (8.3)
CES-D score, mean (± SD)	7.4 (± 7.8)	5.4 (± 6.1)	4.6 (± 7.7)
CES-D ≥16, No. (%)	50 (13.3)	5 (11.9)	1 (8.3)
Medications			
Number used, mean (± SD)	7.8 (± 3.8)	7.3 (± 3.2)	7.1 (± 4.2)
Medications ≥4, No. (%)	349 (92.8)	37 (88.1)	9 (75.0)
CNS-medication use, No. (%) [a]	55 (14.6)	4 (9.5)	1 (8.3)
Fair-to-Poor Health Status, No. (%)	103 (27.4)	5 (11.9)	3 (25.0)
Sleep Disturbance			
ISI score, mean (± SD)	5.0 (± 5.1)	3.6 (± 4.1)	1.8 (± 3.1)
ISI≥8 (insomnia), No. (%)	103 (27.4)	8 (19.0)	1 (8.3)
ESS score, mean (± SD)	6.2 (± 3.7)	4.6 (± 3.3)	5.6 (± 4.1)
ESS≥10 (daytime drowsiness), No. (%)	75 (20.0)	6 (14.3)	2 (16.7)
SACS score, mean (± SD) [c]	10.2 (± 10.3)	9.4 (± 6.6)	13.5 (± 18.1)
SACS>15 (high sleep apnea risk), No. (%)	73 (19.7)	9 (22.5)	2 (18.2)
Drowsy Driving, No. (%) [b]	20 (5.3)	2 (4.8)	0 (0.0)

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; CNS, central nervous system; ESS, Epworth Sleepiness Scale; ISI, Insomnia Severity Index; MMSE, Mini-Mental State Examination; SACS, Sleep Apnea Clinical Score, SD, standard deviation.

[a] Includes benzodiazepines, barbiturates, opiates, antihistamine, antipsychotics, antidepressants, anticonvulsants, or muscle relaxants.

[b] Defined from the Epworth Sleepiness Scale, as a chance of dozing when “in a car, while stopped for a few minutes in traffic”.

[c] There are 8 missing values for the SACS>15 variable, 5 for the Low, 2 for the Medium, and 1 for the High group.

Table 4

Miles driven per day according to insomnia status, using a longitudinal multivariable linear mixed effect model (N = 2004 observations)

Variable	Parameter Estimate [a]	Standard Error	P value
Insomnia (ISI ≥8)	−4.5	1.8	0.01
Six-month interval	−0.2	0.3	0.36
Winter season	0.2	0.8	0.85
Age (years) [b]	−0.4	0.2	0.02
Male	6.1	2.2	0.01
Non-White	−4.7	3.7	0.20
Married	0.1	1.6	0.94
Fair-to-poor health	−3.4	1.9	0.07
MMSE <24	8.3	5.2	0.11
CES-D ≥16	−1.0	2.5	0.67
≥4 medications	−8.3	3.0	0.01
CNS-medication	−1.7	2.3	0.47
Chronic conditions >2	2.8	1.7	0.10

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; CNS, central nervous system; ISI, Insomnia Severity Index; MMSE, Mini-Mental State Examination; SACS.

[a] Parameter estimates indicate the average change over two years of follow-up in miles driven per day for each one step increment in the value of the predictor variable.

[b] Per each year of additional age.