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Sleep Disturbances and Adverse Driving Events in a Predominantly Male Cohort of Active Older Drivers

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Abstract

OBJECTIVES—To evaluate the association between sleep disturbances and adverse driving events among active older drivers.

DESIGN—Longitudinal.

PARTICIPANTS—430 older persons (mean age 78.5 years, 84.9% male), who drove at least once-a-week.

MEASUREMENTS—Baseline measures included self-reported driving patterns and sleep questionnaires—Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS), and Sleep Apnea Clinical Score (SACS). The primary outcome was an adverse driving event, based on self-report and driving records, and categorized as a crash or traffic-infraction (composite-I), or as a crash, traffic-infraction, near-crash, or getting lost (composite-II).

RESULTS—Participants reported driving a median of 17.0 miles/day, with 96.7% (416/430) driving daily or every-other-day. Although 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), the median scores for the ISI, ESS, and SACS were normal at 3.0, 6.0, and 8.0, respectively, and drowsy-driving was reported by only 5.1%. Over a period of up to 2-years, 24.9% (104/418) and 51.4% (215/418) of participants had a composite-I and -II driving event, respectively. In unadjusted and adjusted multivariable models, insomnia, daytime drowsiness, and high sleep apnea risk were not associated with a composite-I or -II driving event.

CONCLUSION—In a predominantly male cohort of active older drivers, sleep disturbances were mild and not associated with adverse driving events. Accordingly, and because older persons are known to self-regulate driving practices, future studies should evaluate whether sleep disturbances are more important as a mechanism that underlies driving cessation, rather than compromising driving safety.

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Keywords

Insomnia; drowsiness; sleep apnea; older drivers

INTRODUCTION

Driving safety in older persons is a rising public health concern.^{1–3} In the United States (U.S.), for example, crash frequency per mile driven begins to increase at around 65 years of age, and is associated with increased bodily-injury and property-damage.^{1,2} Moreover, despite accounting for only 8% of miles driven per year, drivers 65 years or older are presently involved in 14% of U.S. crash fatalities, a figure that is expected to rise to 25% by 2030.¹

Among older persons, prior work has attributed reduced driving safety to cognitive, visual, and physical impairments, but sleep disturbances are rarely evaluated.^{1,4–8} This is in contrast to the general population, for whom sleep disturbances are established risk factors for motor vehicle crashes.^{9–16} Annually, there are about 100,000 sleep-related crashes in the U.S.^{9,10} This is likely an underestimation given that up to 1,000,000 crashes per year are causally related to driver “inattention,” with a contributing factor being sleepiness-induced reductions in vigilance, psychomotor coordination, and cognition.^{9–11} The mechanisms underlying sleepiness-related driver inattention may include sleep deprivation, medications, alcohol, shift work, insomnia, and primary sleep disorders (e.g. obstructive sleep apnea [OSA]).^{9–18}

Sleep disturbances are frequently noted in older persons.^{19–21} In the Established Populations for Epidemiologic Studies of the Elderly (EPESE), involving 9,282 community-living persons 65 years or older, 43% reported insomnia symptoms and 25% napped.¹⁹ Sleep disturbances due to primary sleep disorders are also prevalent in older persons, and often involve OSA.²¹ Nonetheless, rates of drowsy-driving are inexplicably low in older persons, with only 4%–6% of drivers 65 years or older having “dozed-off” while driving, in contrast to 20%–27% of all drivers.^{20,22,23} The low rate of drowsy-driving among older persons could be explained in three ways. First, older persons who continue to drive may not have sleep disturbances. This is unlikely because we have previously shown that a substantial proportion of active older drivers have insomnia (26%) and daytime drowsiness (19%), and these are cross-sectionally associated with lower levels of self-reported driving capacity.²⁴ Second, older drivers who have sleep disturbances may not experience drowsy-driving because they self-adjust driving practices. Prior work has shown that older drivers avoid high-risk settings such as peak traffic times and nighttime,^{5,25} drive shorter distances, 1 or quit driving when safety concerns arise.^{26,27} Third, older drivers who have sleep disturbances may not be aware of drowsy-driving. This is possible because aging is associated with reduced symptom-awareness.²⁸

In the present study, to further determine its potential role as a contributor to reduced driving safety in older persons, we evaluated the longitudinal association of sleep disturbances with adverse driving events, in a predominantly male cohort of active older drivers. As a secondary aim, we also evaluated the frequency of drowsy-driving among older drivers who had an adverse driving event versus those who did not.

METHODS

Study population

Older drivers were recruited from clinic and community sites in greater New Haven, Connecticut. The majority of participants (86%) were from the Veterans Administration Connecticut Healthcare System (VA-CHS). Eligibility criteria included age ≥ 70 years, having access to a telephone, English-speaking, not living in a nursing home or assisted living facility, and currently having a license and driving at least once-a-week. Exclusion criteria included substantial cognitive or vision impairment, defined by a Mini-Mental State Examination (MMSE) score < 18 and distance vision $< 20/70$, respectively.²⁹ Of the 645 participants screened, 496 met eligibility criteria, with 430 also administered sleep questionnaires (i.e., the sleep instruments were a late addition to the study design). 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-CHS Human Investigation Committees approved the study protocol, and all participants gave written informed consent.

Data Collection

Participants underwent on-site assessments by trained research assistants who used standard instruments. Data collected at the time of the baseline interview included age, gender, ethnicity, education, cognition, depression, medications, and self-reported chronic conditions and driving patterns. Cognition was evaluated by the MMSE, with an abnormal score being < 24 .²⁹ Depression was assessed by the Center for Epidemiologic Studies Depression Scale (CES-D), with a score ≥ 16 indicating substantial depressive symptoms.³⁰ Medications were defined in two ways, including the total number of prescription and non-prescription medications and whether participants reported the use of a medication with central nervous system (CNS) effects (i.e., benzodiazepines, barbiturates, opiates, antihistamine, antipsychotics, antidepressants, anticonvulsants, or muscle relaxants). Driving patterns included driving frequency, categorized as daily, every-other-day, or 1–2 times a week, and driving mileage, recorded as the average number of miles per day.

Sleep Questionnaires

We administered validated sleep questionnaires, namely the Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS), and Sleep Apnea Clinical Score (SACS). The ISI is a seven-item questionnaire that is based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria for insomnia.³¹ The response to each item is based on a 0–4 scale, yielding an ISI score that ranges from 0–28, with higher scores signifying more severe symptoms.³¹ An ISI score of ≥ 8 is consistent with a diagnosis of insomnia.³¹

The ESS measures the chance of dozing based on a scale of 0–3, as experienced during eight different activities.³² The ESS score thus ranges from 0–24, with higher scores signifying more severe symptoms.³² Although lacking rigorous validation, two frequently cited diagnostic thresholds for the ESS are scores of 10 and 11.^{32–36} To establish clinically meaningful daytime drowsiness, we opted for an ESS threshold of 10 (or higher), because this has been previously used by the National Sleep Foundation and, among older persons, has been associated with hypertension, stroke, frailty, and lower levels of self-reported driving capacity.^{24,33–36}

Based on a single-item from the ESS, we also evaluated self-reported drowsy-driving. Specifically, we identified drowsy-driving if participants reported a chance of dozing (i.e., slight, moderate, or high) when “in a car, while stopped for a few minutes in traffic”.³²

The SACS instrument is used to assess the clinical risk for OSA, based on the predictor variables of neck circumference, hypertension, habitual snoring (i.e., at least 3 times per week) and partner-reported apneas (i.e., nocturnal choking or gasping at least once-a-week).³⁷ Relative to a reference group having laboratory-confirmed OSA (i.e., an apnea-hypopnea index >10), a SACS<5 confers low risk for OSA, whereas a SACS>15 indicates high risk for OSA.³⁷ SACS values between 5 and 15 are indeterminate.³⁷ In our study protocol, because aging is associated with an increased prevalence of living alone (i.e., no bed partner),³⁸ we modified the SACS instrument to also include self-reported nocturnal choking or gasping, occurring at least once-a-week.

Based on the above sleep questionnaires, we categorized study participants as having a sleep disturbance, if the ISI was ≥ 8 , ESS was ≥ 10 , or the SACS was >15 .^{31,32,37}

Adverse Driving Events

The primary outcome was the occurrence of an adverse driving event, over a planned follow-up of 2-years. This included a crash, traffic-infraction (i.e., a ticket for a moving violation such as speeding, running a red light, or going too slow), near-crash, or getting lost. For crashes and traffic-infractions, these were based on self-report and review of driving records from the Connecticut Departments of Motor Vehicles (DMV) and Transportation (DOT). An occurrence of at least one crash or traffic-infraction was categorized as a composite-I event (i.e., a variable was created indicating whether or not a participant had at least one of these two driving events). For near-crashes and getting lost, these were based on self-report, ascertained by telephone interviews every six months. Prior work has shown that a near-crash increases the risk of a subsequent crash, while getting lost is an important prognostic event for older drivers who have cognitive impairment.^{16,26} The occurrence of at least one crash, traffic-infraction, near-crash, or getting lost was categorized as a composite-II event (i.e., a variable was created indicating whether or not a participant had at least one of these four driving events).

Figure 1 summarizes the analytical sample for adverse driving events. As can be seen, driving follow-up was available in 418 (97.2%) participants. Of these, 373 (89.2%) completed 2-years of follow-up but 45 (10.8%) had less than 2-years, with a median of 12 months (interquartile range [IQR]: 6, 18). Of the 45 participants who had <2-years of follow-up, 24 had no adverse driving event; the most frequent reason for termination of follow-up in these 24 participants was death.

Statistical Analysis

We first described clinical characteristics and measures related to driving and sleep, as counts accompanied by percentages or, depending upon the distribution, as means accompanied by the standard deviation (SD) or as medians accompanied by the IQR. Regarding driving measures, we also evaluated whether indicator variables for individual adverse driving events (i.e., crash, traffic-infraction, near-crash, and getting lost) were correlated with each other (Kendall's tau-b).

We next evaluated whether baseline driving frequency, daily driving mileage, drowsy-driving, and sleep questionnaires (i.e., ISI, ESS, and SACS, as continuous measures) differed significantly among participants who had an adverse driving event (composite-I and -II, respectively) versus those who did not, using chi-square statistics or the Wilcoxon rank sum test.

Finally, we evaluated whether baseline sleep disturbances, defined categorically by an ISI ≥ 8 (i.e., insomnia), ESS ≥ 10 (i.e., daytime drowsiness), a SACS >15 (i.e., high sleep apnea risk), or a variable that included an ESS ≥ 10 or SACS >15 , were longitudinally associated with

adverse driving events, composite-I or composite-II, using unadjusted logistic regression models. These yielded odds ratios that were subsequently adjusted for age, gender, number of chronic conditions, number of medications, use of a medication with CNS-effects, health status, cognitive impairment (MMSE <24), depressive symptoms (CES-D ≥ 16), and mileage driven per day. We investigated potential collinearity problems, and model fit was assessed by residual analysis and goodness-of-fit statistics.

SAS version 9.1.3 (SAS Institute, Cary, NC) was used for all analyses, with *p* values less than the .05 level in two-sided tests reported as statistically significant.

RESULTS

Table 1 shows the characteristics of study participants, including measures related to driving and sleep. As can be seen, participants had a mean age of 78.5 years, were predominantly white men, had 13.2 years of education, and were not cognitively impaired (mean MMSE score >24) nor substantially depressed (mean CES-D score <16). Participants averaged 3.4 chronic conditions and 7.7 medications, with 14.0% (60/430) also reporting the use of a medication with CNS-effects. Self-rated health was endorsed as fair-to-poor in only 25.8% (111/430). Driving patterns showed that 96.7% (416/430) reported driving at least every-other-day, with a median mileage of 17.0 miles/day and a drowsy-driving frequency of only 5.1% (22/430). Sleep questionnaires yielded median scores for the ISI, ESS, and SACS of 3.0, 6.0 and 8.0, respectively; these were substantially lower than the published diagnostic thresholds of 8, 10, and 15, respectively (see methods). 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 a high sleep apnea risk (SACS >15) in 19.9% (84/422). Of the participants who had follow-up for adverse driving events, 24.9% (104/418) and 51.4% (215/418) had at least one composite-I and -II driving event, respectively. The most frequent events in the composite-I and -II categories were crashes and near-crashes, respectively. Of six possible correlations involving individual adverse driving events, only two were statistically significant; crash with traffic-infracton (Kendall's tau-b = 0.16, *p*=0.001), and near-crash with getting lost (Kendall's tau-b = 0.21, *p*<0.001).

Table 2 shows baseline measures of driving and sleep that are categorized according to adverse driving events. As can be seen, relative to those without an adverse driving event, participants who had a composite-I driving event showed no significant differences in baseline driving frequency, driving mileage, drowsy-driving, and sleep questionnaires (i.e., median scores for the ISI, ESS, and SACS) (i.e., all with a *p*>.05). In contrast, participants with a composite-II driving event had a statistically significant increase in driving frequency and ESS, relative to those who had no such event (*p*<.05). Although increased in participants with a composite-II driving event, the median ESS score of 6.0 (IQR: 3.0, 9.0) was in the normal range.

Table 3 shows the odds ratios for having at least one composite-I driving event, categorized according to baseline sleep disturbances, namely insomnia, (ISI ≥ 8), daytime drowsiness (ESS ≥ 10), high sleep apnea risk (SACS >15), or a variable indicating daytime drowsiness or high sleep apnea risk. As can be seen, in unadjusted and adjusted analyses, the presence of a sleep disturbance did not confer statistically significant increased odds of having a subsequent composite-I driving event. Comparable results were found for a composite-II driving event, as shown in Table 4.

DISCUSSION

In a predominantly male cohort of active older drivers, we found that 24.9% and 51.4% of participants had at least one composite-I and -II adverse driving event. Although 26.0% of participants had insomnia ($ISI \geq 8$), 19.3% had daytime drowsiness ($ESS \geq 10$), and 19.9% had a high sleep apnea risk ($SACS > 15$), these sleep disturbances did not confer a statistically significant increase in the odds of having a subsequent adverse driving event, composite-I or -II.

In the general population, sleep disturbances are established risk factors for adverse driving events, including motor vehicle crashes and near-crashes.^{9–16} Nonetheless, in our cohort of active older drivers, sleep disturbances were not associated with a composite-I or -II adverse driving event. We postulate that this lack of an association may reflect the previously noted phenomenon of older persons self-regulating their driving practices.^{5,25–27} Namely, because our study preferentially recruited active drivers, this could have excluded older persons who had stopped driving, as a consequence of a severe sleep disturbance. In support of this hypothesis, we found that our cohort had very mild sleep disturbances, evidenced by median scores for the ISI, ESS, and SACS that were in the normal range.^{31,32,37} This is in marked contrast to other population groups of older persons. To illustrate, using the same ISI and ESS criteria as in the present study, community-living older persons who are frail have prevalence rates for insomnia (47.4%) and daytime drowsiness (36.4%) that are substantially higher than our cohort of active older drivers (26.0% and 19.3%, respectively).³⁶

Age-related factors may have also affected our results. Using the same ESS criteria as in the present study, a national survey of young persons aged 18–29 years previously reported prevalence rates for daytime drowsiness (41.7%) and drowsy-driving (19.4%) that are substantially higher than our cohort of older drivers (19.3% and 5.1%, respectively).³³ These age-related differences may arise via three separate mechanisms. First, chronic sleep loss is more prevalent in younger than older persons. In the same national survey as referenced earlier,³³ persons aged 18–29 years slept on average 20 minutes less each night of the work-week, than persons aged ≥ 65 years.³³ Chronic sleep loss can reduce performance across wakefulness, an effect that is more severe in younger than older persons.^{39–41} A second mechanism is that the importance of primary sleep disorders, such as OSA, may diminish with advancing age.²¹ For instance, hypoxemia attributed to OSA is more severe in younger than older persons.²¹ A third mechanism relates to driving exposure. Prior work has shown that, on average, younger persons aged 30–34 years drive 42.3 miles/day, whereas older persons aged 75–79 years drive only 13.8 miles/day (i.e., extrapolated from self-reported annual mileage);¹ our own cohort of older drivers (mean age 78.5 years) also reported driving shorter distances, averaging only 17.0 miles/day. In general, longer driving distances are associated with drowsy-driving.⁴²

Gender may have been an additional moderating factor to our results, given that our study participants were predominantly male. In general, since older women are more likely to have sleep disturbances than older men,^{43,44} a gender effect could have moderated the association between sleep disturbances and adverse driving events; meaning, the association may be only significant in women. We did not formally test this hypothesis, however, as only 15.1% of study participants were female.

Lastly, among older persons, factors other than sleep disturbances may predominate as a cause of reduced driving safety. As discussed earlier, prior work involving older drivers has shown that cognitive, visual, and physical impairments are associated with reduced driving safety.^{1,4–8}

We recognize potential limitations to our study design. We used sleep instruments that are based on self-report and anthropometric measures. As discussed earlier, aging is associated with reduced symptom-awareness.²⁸ Hence, the ISI and ESS may be limited as an indicator of clinically meaningful sleep disturbances in older persons. Prior work has also shown that neck circumference and self-reported snoring and apneas have diminished predictive capacity for OSA in older persons, thereby potentially limiting the accuracy of the SACS instrument as used in the current study.⁴⁵ Another limitation is that our sample size was powered to detect significant differences only at an odds ratio greater than 2.0. This may have been a factor in the evaluation of sleep apnea risk. For example, we found that a SACS>15 was associated with a 29% increase in the prevalence of a composite-II driving event, but this was not statistically significant (i.e., adjusted odds ratio of 1.29, with a 95% CI of 0.67, 2.47).

In light of the above discussion, to further evaluate the relationship between sleep disturbances and driving performance, future studies will need to 1) enroll a larger and broader spectrum of older persons, including a larger representation of women; 2) implement laboratory testing of sleep disturbances, such as actigraphy, polysomnography, and the maintenance of wakefulness test;^{46–48} and 3) include direct observation of driver performance (e.g. driving simulators), in addition to self-report and review of DMV/DOT driving records.⁴⁹ Moreover, future studies should evaluate whether older persons quit driving as a consequence of sleep disturbances. This may be particularly relevant in older women, given their higher likelihood to have sleep disturbances and to self-regulate driving.^{27,43,44} If proven true, treatment of a sleep disturbance may allow an older person to resume or continue driving safely and, as a result, also reduce social isolation and the risk of subsequent depression.⁵⁰

In conclusion, in a predominantly male cohort of active older drivers, we found that sleep disturbances were mild and not associated with adverse driving events. Accordingly, and because older persons are known to self-regulate driving practices, future studies should evaluate whether sleep disturbances are more important as a mechanism that underlies driving cessation, rather than compromising driving safety.

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Figure 1.

Study sample size for adverse driving events.

* Median (interquartile range) = 12 (6, 18) months

† Of these 24 participants, follow-up was less than 2-years because of death (n=9), quit driving (n=2), unable due to illness (n=4), cognitive impairment (n=1), refused (n=7), and unable to contact (n=1).

Table 1

Characteristics of study participants

Characteristic	Value*
Age (years), mean ($\pm$ SD)	78.5 ($\pm$ 4.9)
Male, n (%)	365 (84.9%)
Non-White, n (%)	21 (4.9%)
Education (years), mean ($\pm$ SD)	13.2 ($\pm$ 2.7)
MMSE score, mean ($\pm$ SD)	27.6 ($\pm$ 1.9)
CES-D score, mean ($\pm$ SD)	7.1 ($\pm$ 7.6)
Chronic conditions, mean ($\pm$ SD)	3.4 ($\pm$ 1.9)
<i>Medications</i>	
Number used, mean ($\pm$ SD)	7.7 ($\pm$ 3.8)
CNS-medication use, n (%) [†]	60 (14.0%)
Self-Rated Health Status (fair-to-poor), n (%)	111 (25.8%)
<i>Driving patterns</i>	
Driving frequency, n (%)	
Daily	308 (71.6%)
Every other day	108 (25.1%)
1–2 times/week	14 (3.3%)
Driving mileage (miles/day), median (IQR)	17.0 (10.0, 25.0) [‡]
Drowsy-driving, n (%) [§]	22 (5.1%)
<i>Sleep questionnaire scores, median (IQR)</i>	
Insomnia severity index (ISI)	3.0 (1.0, 8.0)
Epworth sleepiness scale (ESS)	6.0 (3.0, 9.0)
Sleep apnea clinical score (SACS)	8.0 (4.0, 13.0) [¶]
<i>Sleep disturbances, n (%)</i>	
Insomnia (ISI $\geq$ 8)	112 (26.0%)
Daytime drowsiness (ESS $\geq$ 10)	83 (19.3%)
High sleep apnea risk (SACS $>$ 15)	84 (19.9%) [¶]
<i>Adverse driving events</i>	
Composite-I, n (%) [#]	104 (24.9%) ^{††}
Crash, n	74
Traffic infraction, n	46
Composite-II, n (%) ^{**}	215 (51.4%) ^{††}
Crash, n	74
Traffic infraction, n	46
Near-crash, n	136
Getting lost, n	48

* Based on N=430, unless otherwise noted.

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

[‡]Based on N=429, due to 1 missing data for driving mileage.

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

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

[#]At least one crash or traffic-infraction. Please note that the number of participants with a composite-I outcome is less than the total number of individual adverse driving events, because some participants had more than one event (see methods).

^{**}At least one crash, traffic-infraction, near-crash, or getting lost. Please note that the number of participants with a composite-II outcome is less than the total number of individual adverse driving events, because some participants had more than one event (see methods).

^{††}Based on N=418, due to 12 missing data for adverse driving events.

SD = standard deviation; IQR = interquartile range; MMSE = MiniMental State Examination; CES-D = Center for Epidemiologic Studies Depression Scale; CNS = central nervous system.

Table 2

Baseline driving patterns and sleep questionnaire scores, according to adverse driving events

Characteristic	Adverse Driving Events [*]			
	Composite-I [†]		Composite-II [†]	
	None	At least one	None	At least one
	Median (IQR) or n (%)			
<i>Driving patterns</i>				
Driving frequency:	N=314	N=104	N=203	N=215
Daily	224 (71.3%)	79 (76.0%)	137 (67.5%)	166 (77.2%) [‡]
Every other day	80 (25.5%)	21 (20.2%)	58 (28.6%)	43 (20.0%)
1–2 times/week	10 (3.2%)	4 (3.8%)	8 (3.9%)	6 (2.8%)
Driving mileage (miles/day)	N=313	N=104	N=203	N=214
	16.0 (10.0, 25.0)	18.0 (10.0, 29.5)	20.0 (10.0, 28.0)	15.5 (10.0, 25.0)
Drowsy-driving [§]	N=314	N=104	N=203	N=215
	16 (5.1%)	6 (5.8%)	9 (4.4%)	13 (6.0%)
<i>Sleep questionnaire scores</i>				
Insomnia severity index	N=314	N=104	N=203	N=215
	3.0 (1.0, 8.0)	3.0 (1.0, 6.0)	3.0 (1.0, 8.0)	3.0 (1.0, 8.0)
Epworth sleepiness scale	N=314	N=104	N=203	N=215
	6.0 (3.0, 9.0)	6.0 (3.0, 9.0)	5.0 (3.0, 8.0)	6.0 (3.0, 9.0) [‡]
Sleep apnea clinical score	N=308	N=102	N=200	N=210
	8.0 (4.0, 13.0)	8.0 (4.0, 15.0)	8.0 (3.5, 13.0)	8.0 (4.0, 15.0)

* Categorized as composite-I, which included at least one crash or traffic-infraction, and as composite-II, which included at least one crash, traffic-infraction, near-crash, or getting lost.

[†] Statistically significant differences in characteristics, among participants who had an adverse driving event (composite-I and –II, respectively) versus those who did not, were tested by chi-square and Wilcoxon rank sum tests, where appropriate.

[‡] Significant at a p value <.05.

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

IQR= interquartile range.

Table 3

Odds ratios for having a composite-I adverse driving event, according to baseline sleep disturbance

Sleep Disturbance	N	n (%) [†]	Composite-I Adverse Driving Event [*]	
			Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio [‡] (95% CI)
Insomnia				
ISI <8 (no insomnia)	309	82 (26.5)		1.00
ISI ≥8 (insomnia)	109	22 (20.2)	0.70 (0.41, 1.19)	0.59 (0.33, 1.06)
Daytime drowsiness				
ESS <10 (no drowsiness)	339	83 (24.5)		1.00
ESS ≥10 (daytime drowsiness)	79	21 (26.6)	1.12 (0.64, 1.95)	0.98 (0.55, 1.76)
Sleep apnea risk				
SACS <5 (low risk)	130	30 (23.1)		1.00
SACS 5-15 (indeterminate risk)	197	51 (25.9)	1.16 (0.69, 1.95)	1.17 (0.64, 2.15)
SACS >15 (high risk)	83	21 (25.3)	1.13 (0.59, 2.14)	1.10 (0.52, 2.36)
Daytime drowsiness or high sleep apnea risk (ESS ≤10 or SACS >15)				
No	275	67 (24.4)		1.00
Yes	140	36 (25.7)	1.08 (0.67, 1.72)	1.00 (0.61, 1.65)

* Included at least one crash or traffic-infraction.

[†] Percent of row.

[‡] Adjusted for age, gender, number of chronic conditions, number of medications, use of a medication with CNS adverse effects, health status, cognitive impairment (MMSE <24), depressive symptoms (CES-D ≥16), and miles per day of driving.

CI = confidence interval; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale; SACS = Sleep Apnea Clinical Score.

Table 4

Odds ratios for having a composite-II adverse driving event, according to baseline sleep disturbance

Sleep Disturbance	N	Composite-II Adverse Driving Event [*]		
		n (%) [†]	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio [‡] (95% CI)
Insomnia				
ISI <8 (no insomnia)	309	157 (50.8%)		1.00
ISI ≥8 (insomnia)	109	58 (53.2%)	1.10 (0.71, 1.71)	0.96 (0.60, 1.54)
Daytime drowsiness				
ESS <10 (no drowsiness)	339	171 (50.4%)		1.00
ESS ≥10 (daytime drowsiness)	79	44 (55.7%)	1.24 (0.75, 2.02)	1.11 (0.67, 1.86)
Sleep apnea risk				
SACS <5 (low risk)	130	64 (49.2%)		1.00
SACS 5–15 (indeterminate risk)	197	98 (49.7%)	1.02 (0.66, 1.59)	0.98 (0.58, 1.64)
SACS >15 (high risk)	83	48 (57.8%)	1.41 (0.81, 2.46)	1.29 (0.67, 2.47)
Daytime drowsiness or high sleep apnea risk (ESS ≥10 or SACS >15)				
No	275	135 (49.1%)		1.00
Yes	140	78 (55.7%)	1.31 (0.87, 1.96)	1.22 (0.79, 1.88)

* Included at least one crash, traffic-infraction, near-crash, or getting lost.

[†] Percent of row.

[‡] Adjusted for age, gender, number of chronic conditions, number of medications, use of a medication with CNS adverse effects, health status, cognitive impairment (MMSE <24), depressive symptoms (CES-D ≥16), and miles per day of driving.

CI = confidence interval; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale; SACS = Sleep Apnea Clinical Score.