

Gender effect on driving cessation in pre-dementia and dementia phases: results of the 3C population-based study

Laetitia Marie Dit Asse¹, Colette Fabrigoule², Catherine Helmer³, Bernard Laumon¹, Claudine Berr⁴, Olivier Rouaud⁵, Sophie Auriacombe⁶ and Sylviane Lafont¹

¹Univ Lyon, Université Claude Bernard Lyon1, Ifsttar, UMRESTTE, Bron, France

²USR 3413 CNRS/Université Bordeaux Segalen, Bordeaux cedex, France

³Centre INSERM U897-Epidemiologie-Biostatistique, ISPED, Bordeaux, France

⁴INSERM U1061 - Hôpital La Colombière, Montpellier Cedex 5, France

⁵Centre Mémoire de Ressources et de Recherche, Bocage Central, Dijon, France

⁶Centre Mémoire de Ressources et de Recherche, Bordeaux Cedex, France

Correspondence to: S. Lafont, E-mail: sylviane.lafont@ifsttar.fr

Objectives: Aging entails deterioration in sensory, physical, and cognitive functions, raising doubt in the driving capacity of older drivers, especially when the deficits are severe, as in dementia. Many older drivers, especially women, adapt their driving habits in order to compensate for these deficits and eventually stop driving. The present prospective study assessed driving cessation in men and women throughout the dementia process, including a 2-year pre-dementia phase.

Methods: The study was based on a three-city cohort of subjects who were aged 65 years and older in 2000 and followed for more than 10 years. Active dementia detection was conducted at each follow-up. The probability of driving cessation was assessed in men and women during the 2-year pre-dementia phase and until 5 years after diagnosis.

Results: In the 2-year pre-dementia phase, both men and women ceased driving earlier than drivers with no central nervous system pathology ($p < 0,001$), and women ceased driving earlier than men. A total of 45% of men and 74% of women had already ceased driving at dementia diagnosis. In contrast, the probability of cessation within 3 years after diagnosis was similar between men and women.

Conclusion: The study showed that, in this French urban population, few demented drivers, especially women, were still driving after diagnosis. Those who continued to drive 3 years after the diagnosis all had Alzheimer-type dementia. There is certainly a need for physicians to help these drivers to adapt their driving activity to their deficits and to prepare them to stop driving. Copyright © 2016 John Wiley & Sons, Ltd.

Key words: dementia; pre-dementia; gender; driving cessation; cohort study; older drivers

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Introduction

Driving is a complex activity that calls on sensory, physical, and cognitive functions (Anstey *et al.*, 2005). Visual acuity, contrast sensitivity, glare tolerance, and an intact visual field are essential to ensure basic sensory information regarding the place, other vehicles, road users, and possible dangers (Anstey *et al.*, 2012; Higgins and Wood, 2005). Physical requirements comprise muscle force and grip for

handling the steering wheel and good head rotation capacity, for example, to check blind spots (Anstey *et al.*, 2005). The cognitive functions involved are numerous (Anstey *et al.*, 2005; Carr *et al.*, 2006); the most important are attentional processes and executive functions that enable the integration of information and the anticipation and preparation of adapted sensorimotor and cognitive responses (Adrian *et al.*, 2011). Driving also requires good working memory to keep relevant information in mind during the

decision-making process. Finally, sufficient speed of information processing is necessary. However, some of these functions and processes are slightly altered during normal aging; the slowing of information processing is observed, accompanied by attentional deficits (Hasher *et al.*, 1991; Jacqmin-Gadda *et al.*, 1997; Salthouse and Meinz, 1995). These deficits become greater and are accompanied by problems with executive function for individuals with brain pathologies, such as dementia of Alzheimer type or other dementias (Amieva *et al.*, 1998; Parasuraman and Haxby, 1993), raising doubt in their driving capacity (Man-Son-Hing *et al.*, 2007).

For persons developing dementia, longitudinal prospective studies have described a phase where cognitive performances progressively deteriorate until they are severe enough to significantly affect the instrumental activities of daily living, the defining characteristic of dementia. In these studies, the beginning of the deterioration has been observed to range from 9 to 12 years before the diagnostic criteria of dementia are met (Amieva *et al.*, 2005; Kawas *et al.*, 2003; Rajan *et al.*, 2015). In the few years preceding dementia diagnosis, these cognitive deficits may be sufficient enough to affect driving safety. This may explain the increased crash risk found 2 years before dementia (Lafont *et al.*, 2008). Consequently, it is important to explore the process of driving cessation in the phase just preceding a dementia diagnosis.

In parallel, drivers experience an effective adaptation of driving behavior to sensory and physical changes, which is often observed for most pathologies. Older drivers change their way of driving by reducing driving exposure (i.e., frequency or mileage) (Stutts, 1998), avoiding certain driving situations (Ross *et al.*, 2009b), or ceasing to drive (Dickerson *et al.*, 2007). For many drivers, ceasing to drive is a difficult decision as driving determines autonomy and quality of life (Tuokko *et al.*, 2007; Wu *et al.*, 2015). There are differences between men and women in this regard; numerous studies on the general population reported that older women ceased driving earlier than men (Anstey *et al.*, 2006; Chipman *et al.*, 1998; Choi *et al.*, 2012; Freund and Szinovacz, 2002; Lafont *et al.*, 2008; Marie Dit Asse *et al.*, 2014; Ross *et al.*, 2009a; Sims *et al.*, 2011; Unsworth *et al.*, 2007).

Because women cease driving earlier than men, it is crucial to question the gender effect during the evolution to dementia. In the dementia phase, two studies failed to demonstrate a gender effect on driving cessation after diagnosis of dementia (Gilley *et al.*, 1991; Herrmann *et al.*, 2006). In the two years preceding dementia, we demonstrated in a previous study that

women limited their driving activity more than men compared with a population free of neurological pathology (Marie Dit Asse *et al.*, 2014). In that study, the outcome was driving restriction, defined either by a reduction in driving distance or by driving cessation during the follow-up period.

In the present prospective study, we assessed the gender effect on driving cessation according to age in the 2-year time period before dementia diagnosis and in the 5 years after diagnosis, with an active detection of dementia at each follow-up.

Methods

Study population

The study was based on the three-city (3C) cohort of subjects aged 65 years and older. The principal objective of the 3C study was to analyze the relation between vascular factors and dementia (The 3C Study Group, 2003). Participants were randomly selected from the electoral rolls of three French cities (Bordeaux, Dijon, and Montpellier). The eligibility criteria were an age ≥ 65 years and not residing in an institution. All the participants were volunteers, and no financial payments were made. The inclusion period was from March 1999 to March 2001.

Data collection

The data collection procedures were the same at inclusion and at the 2-year, 4-year, 7-year, and 10-year follow-up. A specially trained psychologist filled in a general questionnaire and assessed cognitive performance, and a nurse completed the clinical health data. For driving data, a self-administered questionnaire was completed at inclusion. For the 2-year, 4-year, 7-year, and 10-year follow-up, a few questions about driving status were included in the general questionnaire filled in by the psychologist.

For subjects lost to follow-up, vital status was systematically investigated from birthplace municipal records. The study protocol was approved by the institutional review board of the Kremlin-Bicêtre University Hospital (Paris, France).

Diagnosis of dementia

The diagnosis of dementia was based on a 3-step procedure (The 3C Study Group, 2003). Trained

psychologists administered a battery of neuropsychological tests at baseline and at each follow-up examination. Further data were collected: basic and instrumental activities of daily living and severity of cognitive disorders. All the participants were examined by a neurologist at baseline. At follow-up, only the participants who were suspected of dementia on the basis of their neuropsychological performance were examined by the neurologist. Finally, an independent committee of neurologists reviewed all potential prevalent and incident cases of dementia to obtain a consensus on the diagnosis and etiology according to the criteria from the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (American Psychiatric Association (APA), 1994). This procedure, implemented at each follow-up, enabled an *a posteriori* 2-year pre-dementia phase to be determined as a time period, that is, the subject did not have dementia at one follow-up but was diagnosed with dementia at the next follow-up (2.6 years later on average).

Cognitive evaluation

Among the neuropsychological tests conducted at each follow-up, the mini-mental state examination (MMSE) (Folstein *et al.*, 1975) and the trail making test part B (TMT-B) (Reitan, 1958) were used in this paper in order to describe the cognitive level of the demented drivers. The MMSE is a test of global cognitive level that evaluates orientation (place and time), attention, memory, arithmetic, language, and visual construction (range 0–30). In the TMT-B, the subject is asked to connect numbers (from 1 to 13) and letters (from A to L) alternatively in ascending order as quickly as possible. The time taken to complete the test and the number of correct transitions were recorded. In this study, the time per correct transition was analyzed as a measure of treatment speed in a test of executive function.

Demographic and socioeconomic factors

Sociodemographic information included living arrangement (alone or not) and education level. No schooling or a primary school level education was considered to be equivalent to 0 to 5 years of schooling, a secondary level education was considered to be equivalent to 6 to 11 years of schooling and a university level education was considered to be equivalent to 12 or more years of schooling.

Driving status and age at driving cessation

Whether the subject had a driver's license was recorded at inclusion. Driving status (active driver or not) and age at cessation were recorded in all the questionnaires at inclusion and at each follow-up.

Statistical analysis

All the analyses were performed for male and female subjects separately. For the cohort as a whole, driving status was described at inclusion. For demented participants, a figure described their driving status at inclusion, at diagnosis and after diagnosis.

The probability of driving cessation according to age was assessed for male and female active drivers with survival curves. The impact of sex on the cessation process was then analyzed for the 2-year pre-dementia phase and after dementia diagnosis. For this analysis, pre-demented subjects were free of Parkinson's disease, stroke, and cerebral trauma that induced ≥ 24 h of lost consciousness. In order to define the 2-year pre-dementia phase as a time period, participants who were not examined before diagnosis of dementia were excluded from these analyses.

The cessation probability of participants in the 2-year pre-dementia phase was compared with that of participants without central nervous system (CNS) pathology during follow-up. The cessation probability of incident demented subjects was assessed according to the interval (in years) between the age at diagnosis and the age at driving cessation, and between the age at diagnosis and the age at the end of follow-up for subjects who did not cease driving (Figure 1). For instance, an individual only surveyed 1 year after dementia diagnosis would be considered censored for subsequent years.

The various driving cessation probabilities with their 95% confidence intervals were assessed with Cox proportional hazards regression models with age as the time scale. The comparisons between the means of two groups (male versus female and drivers versus ex-drivers) were performed with Student *t*-tests. The analyses were conducted using SAS software version 9.2 (SAS Institute, Inc., Cary, NC, USA).

Results

Characteristics of the population

The 3C-cohort study included 9294 drivers aged 65 years and older, comprised 3650 men and 5644 women. Among them, 7203 were licensed holders,

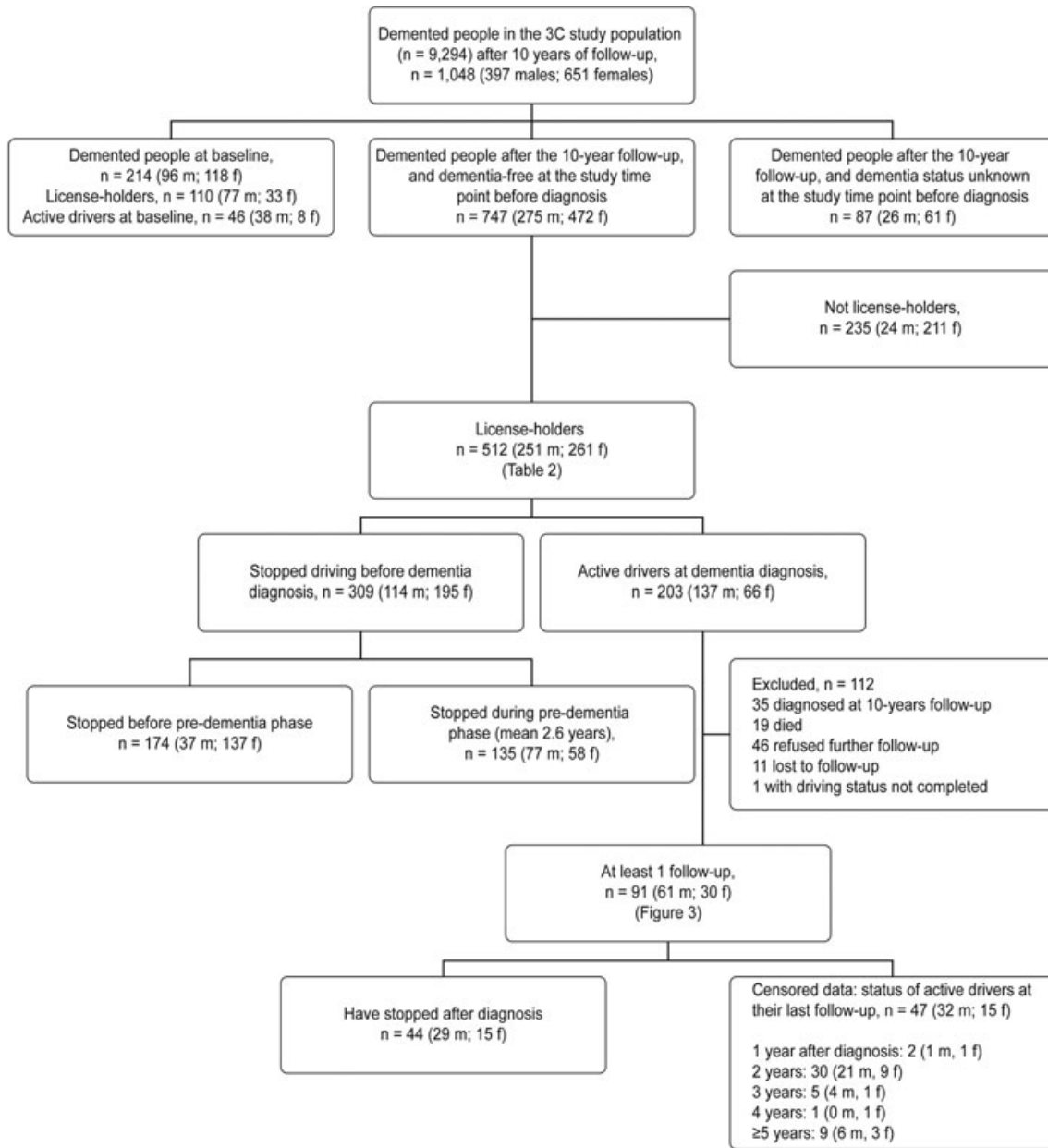


Figure 1 Demented people among the 3C study population

composed of 95.4% men and 65.9% women. The rates of active male and female drivers were strongly different; 91.2% of male license holders were drivers at inclusion compared with 67.2% of females [Table 1]. The rate of active driving fell with age in both men and women. This rate was 95.9% among men under 75 years of age, 91.5% among men aged 75 to 79 years, 77.9% among men aged 80 to 84 years and 57.1% among men aged over 85 years; among women, the proportions were 75.3%, 58.9%, 46.4%, and 19.7%, respectively.

Male ex-drivers were less educated, more likely to live alone and had lower cognitive scores than active male drivers. Female ex-drivers were also less educated and had lower cognitive scores than active female drivers.

Two hundred and fourteen of the 9294 subjects had dementia at inclusion: 96 female and 118 male subjects (Figure 1). Over the 10-year follow-up period, 747 cases of incident dementia were diagnosed (dementia-free status at the previous study time point), and among them, 512 were driver license holders

Table 1 Characteristics of license holders according to their driving status at inclusion, *n* = 7,203

	Ex-drivers %	Active drivers %	<i>p</i> -value
Men	<i>n</i> = 308	<i>n</i> = 3174	
Age ^a , mean (SD)	79.3 (6.7)	73.5 (5.1)	<0.001
Education ^b (%)			0.001
0 to 5 years	41.4	32.9	
6 to 11 years	24.8	26.3	
≥12 years	33.9	40.8	
Living arrangement ^a , (% alone)	21.8	13.4	<0.001
MMSE ^a score, mean (SD)	26.0 (3.0)	27.4 (1.9)	<0.001
TMT-B ^a score, mean (SD)	11.5 (12.2)	6.9 (8.5)	<0.001
Women	<i>n</i> = 1220	<i>n</i> = 2501	
Age ^a , mean (SD)	75.5 (5.9)	72.5 (4.5)	
Education ^b (%)			<0.001
0 to 5 years	39.2	30.1	
6 to 11 years	35.6	35.0	
≥12 years	25.2	34.9	
Living arrangement ^a , (% alone)	47.3	49.1	0.3
MMSE ^a score, mean (SD)	27.2 (2.2)	27.6 (1.8)	<0.001
TMT-B ^a score, mean (SD)	7.7 (7.8)	6.2 (8.2)	<0.001

SD, standard deviation; MMSE, mini-mental state examination; trail making test part B, TMT-B.

^aAt inclusion.

^bNumber of years of schooling.

^cTotal time divided by the number of correct transitions.

(68.5%). Among these license holders, 346 had a dementia of Alzheimer type, 59 had mixed dementia, 42 had vascular dementia, 22 had Parkinson's

dementia, and 20 had Lewy body dementia. The 23 other dementia patients had frontotemporal dementia (*n* = 6), progressive supranuclear palsy (*n* = 3), primary progressive aphasia (*n* = 1), herpes-related dementia (*n* = 1), dementia with normal pressure hydrocephalus (*n* = 2), dementia with a cerebral tumor (*n* = 1), meningioma and hydrocephalus (*n* = 1), psychiatric dementia (*n* = 1), corticobasal dementia (*n* = 1), and alcohol-related dementia (*n* = 1).

Driving cessation in male and female subjects aged 65 years and older

There were 5254 drivers that were followed up at least once over the 10-year study period. They had a mean age of 72.9 years (standard deviation; SD = 4.9 years), and 54.7% were males. A total of 85.9% were free of dementia and other CNS pathologies over the 10 years of follow-up.

The probability of driving cessation increased strongly with age in both men and women (Figure 2). Female subjects showed a higher probability of driving cessation than male subjects at all ages (*p* < 0.001). By the age of 85, more than half of the female subjects who drove at inclusion had ceased to drive compared with one third of male subjects.

Driving status at diagnosis of dementia

Three hundred and nine (60.0%) of the 512 demented license holders had already ceased driving before the diagnosis, with 2.2 times more women than men

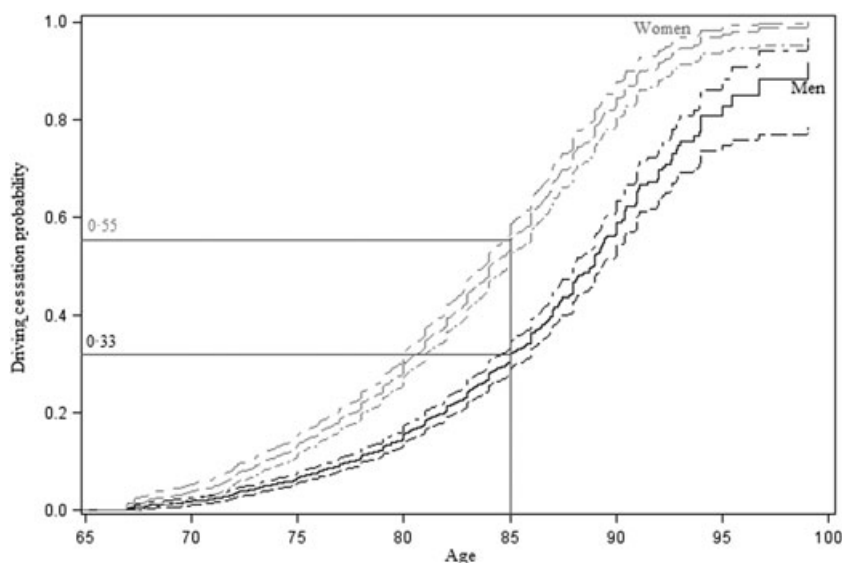


Figure 2 Probability of driving cessation according to age in men and women (CI 95%)

(74.7% and 45.4%, respectively) (Figure 1). Among both male and female demented subjects, those who drove at diagnosis were younger, were more frequently diagnosed with Alzheimer's disease than other types of dementia and had better MMSE scores than those who had ceased driving (Table 2).

Driving cessation in the pre-dementia phase

Among the 309 demented people who had stopped driving before diagnosis, 43.7% had ceased during the 2-year pre-dementia phase (mean = 2.6 years), and 56.3% ceased before this phase (Figure 1); among men, the respective rates were 67.5% and 32.5%; and

Table 2 Characteristics of license holders according to their driving status at dementia diagnosis, $n = 512$

	Ex-drivers %	Active drivers (%)	<i>p</i> -value
Men, $n = 251$	$n = 114$	$n = 137$	
Age ^a , mean (SD)	84.7 (5.8)	80.2 (5.1)	<0.001
Education ^b (%)			0.4
0 to 5 years	38.6	45.9	
6 to 11 years	24.6	24.4	
≥12 years	36.8	29.6	
Living arrangement ^a , (% alone)	20.2	13.9	0.2
Dementia ^a (%)			<0.001
Alzheimer	49.1	77.4	
Mixed dementia	16.7	11.7	
Vascular dementia	16.7	4.4	
Parkinson dementia	9.7	1.5	
Lewy body dementia	4.4	1.5	
Other	3.4	3.7	
MMSE ^a score, mean (SD)	22.1 (3.4)	23.3 (2.7)	0.01
TMT-B ^a score, mean (SD)	16.9 (12.5)	17.3 (20.6)	0.9
Women, $n = 261$	$n = 195$	$n = 66$	
Age ^a , mean (SD)	83.9 (5.5)	79.4 (4.7)	<0.001
Education ^b (%)			0.5
0 to 5 years	41.1	46.2	
6 to 11 years	30.5	32.3	
≥12 years	28.4	21.5	
Living arrangement ^a , (% alone)	54.5	51.5	0.7
Dementia ^a (%)			<0.001
Alzheimer	65.6	84.9	
Mixed dementia	10.8	4.6	
Vascular dementia	8.2	1.5	
Parkinson dementia	4.6	0.0	
Lewy body dementia	6.2	1.5	
Other	4.6	7.6	
MMSE ^a , mean (SD)	21.9 (4.0)	22.4 (2.1)	<0.001
TMT-B ^a , mean (SD)	19.5 (13.5)	16.5 (12.8)	0.1

MMSE, mini-mental state examination; trail making test part B, TMT-B.

^aAt dementia diagnosis.

^bNumber of years of schooling.

^cTotal time divided by the number of correct transitions.

among women, the rates were 29.7% and 70.3%, respectively. Most women had stopped driving before the 2-year pre-dementia phase because the average time between the age at driving cessation and the age at dementia diagnosis was 4.1 years (SD = 2.5 years) for females versus 2.5 years (SD = 2.0 years) for males.

The probability of cessation in the 2-year pre-dementia phase increased more strongly with age than for those without a CNS pathology in both men and women (Figure 3). This probability was higher in female subjects than in male subjects at all ages; the probability of cessation by the age of 85 years was 0.78 in female subjects with pre-dementia and 0.53 in male subjects with pre-dementia.

Driving cessation according to the interval (in years) after diagnosis

This assessment was performed on the 91 subjects, composed of 61 male and 30 female subjects, with incident dementia who were still driving at the time of diagnosis and were followed up at least once after diagnosis (Figure 1). One hundred and twelve subjects with dementia were not included in this analysis: 35 were diagnosed at the 10-year follow-up (last follow-up, precluding analysis); 19 died; 46 refusing further follow-up; 11 were lost to follow-up; and 1 failed to report driving status. Compared with the 91 subjects with dementia driving at diagnosis and with at least 1 follow-up, those who were not included in this analysis were slightly older at diagnosis (mean = 80.6 years, SD = 4.6 years vs. mean = 79.2 years, SD = 5.3 years; $p = 0.04$) and had lower MMSE scores at the time of diagnosis (mean = 22.5, SD = 2.6, vs. mean = 23.5, SD = 2.4; $p = 0.01$).

Twenty-nine of the 61 males ceased driving during follow-up, and 32 were active drivers at their last follow-up exam and were censured at that exam (11 deaths). Fifteen of the 30 female subjects ceased driving during follow-up, and 15 were active drivers at their last follow-up exam and were censured at that exam (1 death).

Among male subjects, the probability of driving cessation was 0.26 (95% confidence interval; CI: 0.15–0.36) within 1 year of diagnosis of dementia, 0.41 (95% CI: 0.24–0.54) within 3 years and 0.63 (95% CI: 0.40–0.77) within 5 years compared with 0.27 (95% CI: 0.10–0.41), 0.46 (95% CI: 0.21–0.63), and 0.64 (95% CI: 0.28–0.82), respectively, among females (Figure 4).

Gender, the age at diagnosis, the type of dementia, educational level, lifestyle, and MMSE and TMT-B

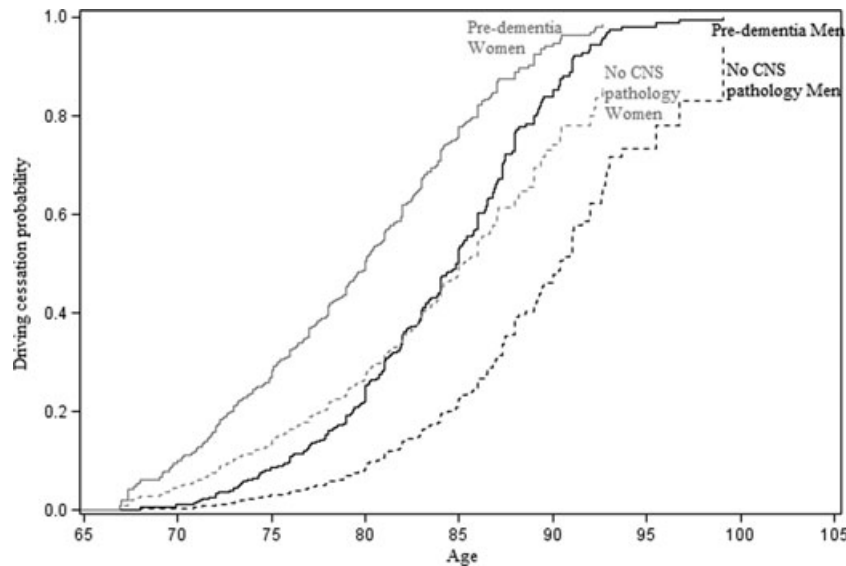


Figure 3 Probability of driving cessation according to pre-dementia status

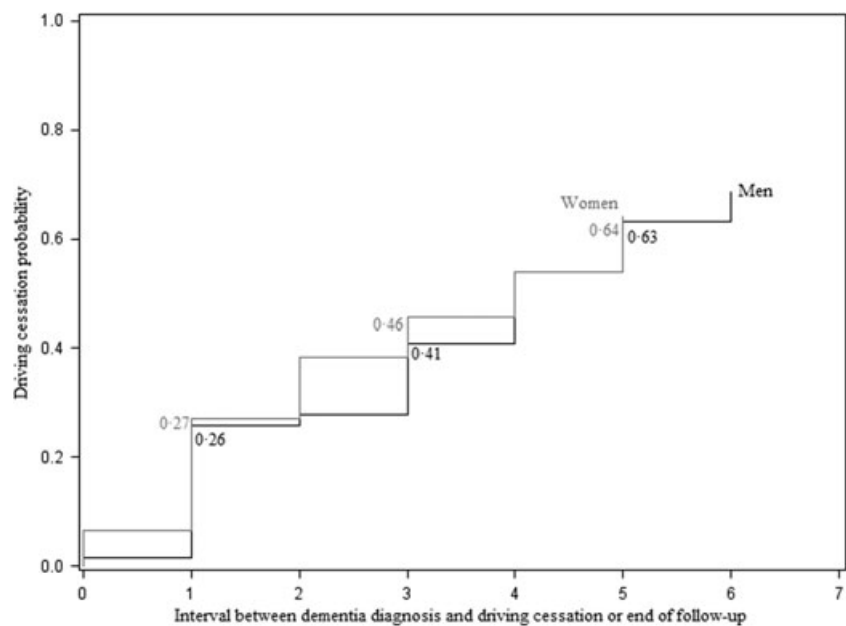


Figure 4 Probability of driving cessation after diagnosis of dementia in men ($n = 61$) and women ($n = 30$)

scores were compared between the 23 demented participants who were still driving 3 years after diagnosis and the 36 participants who had stopped driving within 3 years. The proportion of Alzheimer-type dementia was significantly higher in subjects driving 3 years after the diagnosis than in subjects who stopped driving within 3 years (100% vs. 69.4%; $p = 0.003$). No other differences were significant; however, some tendencies included that those who were still driving 3 years after diagnosis were younger and

had a better speed of treatment performance in the TMT-B test.

Discussion

In 2000, in a population of almost 10,000 older people living at home with a mean age of 74 years, the proportion of active drivers was 61%, with twice as many men as women. Among subjects driving at inclusion,

the probability of driving cessation during follow-up significantly increased with age and was higher in female subjects. Male and female subjects in the 2-years pre-dementia phase ceased driving earlier than drivers with no CNS pathology. The gender effect on driving cessation was still present; in this phase, female subjects ceased driving earlier than male subjects. This accounts for the difference in rates of driving at the time of diagnosis between male and female license holders: 55% and 27%, respectively. In contrast, the gender effect disappeared after diagnosis, because the probability of cessation within 3 years was very similar in male and female subjects (0.41 and 0.46, respectively).

The modulation of the age effect on driving cessation by gender confirms the literature data (Anstey *et al.*, 2006; Chipman *et al.*, 1998; Choi *et al.*, 2012; Freund and Szinovacz, 2002; Lafont *et al.*, 2008; Marie Dit Asse *et al.*, 2014; Ross *et al.*, 2009a; Sims *et al.*, 2011; Unsworth *et al.*, 2007). Cultural and social factors may explain this gender effect (Choi *et al.*, 2013); culturally, a car is a symbol of speed, youth and masculinity, which may encourage highly masculinized use of motor vehicles (Siren and Hakamies-Blomqvist, 2005). Other authors suggest that women may be more inclined to admit deterioration in their driving performance and to change their habits (D'Ambrosio *et al.*, 2008; Siren and Meng, 2013).

The originality of the present results lies in its assessment of the probability of driving cessation from the 2-year pre-dementia phase to 5 years after diagnosis. It is important to note that pre-dementia affected the age of driving cessation in both men and women but even more in women. Concerning this gender effect in the pre-dementia phase, we had already shown a greater rate of driving restriction among women than among men in a subsample of this population restricted to the Bordeaux area (Marie Dit Asse *et al.*, 2014). The present findings resulted in a higher rate of active drivers at diagnosis among men than among women, with a sex-ratio of 2.2. The literature also reports a gender effect on driving cessation at diagnosis of dementia. Herrmann *et al.* found a sex-ratio of approximately 2 for active drivers in an early dementia population that was slightly younger than the present cohort (mean = 77 years) (Herrmann *et al.*, 2006). Seiler *et al.* reported a lower sex-ratio of approximately 1.4 in a slightly younger early dementia population (mean = 74 years) (Seiler *et al.*, 2012).

After diagnosis, studies that used survival curves to study gender effects, similar to the present study, confirmed the absence of a gender-related difference. Herrmann *et al.* found a cessation probability of 0.72 3 years after diagnosis with no significant gender

differences (Herrmann *et al.*, 2006). In a retrospective study, Gilley *et al.* found a cessation probability of 0.60 3 years after the first signs of dementia also with no significant gender differences (Gilley *et al.*, 1991).

Among the number of drivers who presented with dementia in this study, it is noteworthy that very few continued to drive 3 years after the diagnosis, and they all had a diagnosis of Alzheimer's disease. This may be due to differences in cognitive profiles because patients with dementia of Alzheimer type present more profound memory deficits but less executive function and treatment speed deficits than most other dementia types (Dong *et al.*, 2013; Levy and Chelune, 2007) in which the ability to drive is certainly more profoundly affected even in the first stages. Gilley *et al.* also found that Alzheimer patients continued to drive for more years than those with other dementia syndromes (Gilley *et al.*, 1991). We did not find a higher performance of treatment speed in our study; only a slight tendency was found, which is consistent with the literature. In a clinical context, it is nevertheless necessary to follow the evolution of cognitive performances of demented patients who continue to drive. In most countries, there exists legislation on the driving of demented persons. However, as underlined by Carter *et al.*, 'all worldwide legislation has a propensity to recommend that a diagnosis of dementia alone is not adequate enough to withdraw an individual's license to drive' (Carter *et al.*, 2015). The authors propose guidance for how to address driving cessation in dementia. In the case where the license holder decides to cease driving, he or she should be accompanied during the mobility transition. If he wants to continue to drive, then he is directed to the driver and vehicle licensing agency to undergo a procedure with the doctor in order to decide whether the patient is fit to drive. In France, where the doctors have to inform their patients but not the legal authorities, a short cognitive protocol has been developed to help doctors to detect cognitive deficits that may affect driving safety and to counsel their patients (Fabrigoule *et al.*, 2012).

One of the main results of this study is the high rate of driving cessation in the 2 years preceding dementia diagnosis and even before. It is possible that some of these persons intuitively sense cognitive changes. It is possible that some of these persons intuitively sense cognitive changes through slight deterioration of instrumental activities of daily living demonstrated at this stage (Barberger-Gateau *et al.*, 1999). Regarding driving, the progressive cognitive decline induces more driving discomfort (Meng and Siren, 2012) and more driving stress (Hakamies-Blomqvist and Wahlstrom,

1998), leading to self-regulation of driving, including cessation.

Several strengths and limitations should be stressed about the present study. Our findings were based on a large cohort whose main objective was to study the relationship between vascular factors and dementia. Consequently, one weakness was that the present analysis had limited information about driving habits, that is, whether they were an active driver or not, age and main reason for driving cessation (personal, medical or other). These reasons were not precise enough to know whether the stop was self or medically imposed, and no information about alternative methods of transportation was available. Another limitation of the study was that all the participants lived in middle-size cities of France with public transport, which may influence the decision to cease driving. Consequently, the high rate of cessation observed in our study may better reflect the reality of driving cessation in urban areas rather than the population as a whole. Additionally, the small number of subjects with dementia followed up after diagnosis, leading to an imprecise estimation of cessation probability, especially 5 years after diagnosis. Furthermore, the information provided to subjects at diagnosis about the impact of the disease on driving capacity was not known. A strength, however, was the examination for dementia at each follow-up in all participants, thus allowing the identification of undiagnosed cases by their usual medical doctor. Hence, the present findings are probably more representative of driving cessation in the population than most clinical samples.

Conclusion

The present study showed that few demented subjects continue to drive after diagnosis and that the majority, especially among women, cease driving in the years before the diagnosis. Demented subjects who were still driving at diagnosis were younger, had better global performance and more frequently had a diagnosis of Alzheimer's disease than another type of dementia. Those who continued to drive 3 years after the diagnosis all had a dementia of Alzheimer type. There is certainly a need for physicians to help these drivers to adapt their driving activity to their deficits and to prepare them to stop.

Conflict of interest

None declared.

Key-points:

- In the 2-year pre-dementia phase, both male and females ceased driving earlier than drivers with no CNS pathology.
- The probability of cessation within 3 years after diagnosis was similar between men and women.
- All the subjects who continued to drive 3 years after their diagnosis had Alzheimer-type dementia
- We provided an imprecise estimation of cessation probability 3 and 5 years after the diagnosis due to a small number of subjects

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Sponsor's Role

None.

Author contributions

All the authors contributed significantly to the work. Fabrigoule and Lafont contributed to the analysis strategy, interpreted the results and revised the work critically for important intellectual content. Laumon revised the manuscript critically for important intellectual content. Helmer, Berr, Auriacombe, and Rouaud contributed to the acquisition of the data and revised the manuscript. Marie dit Asse contributed to the analysis, interpreted the data, and drafted the article.

This manuscript has not been published, considered for publication, or sent to be considered for publication elsewhere. I state on behalf of all the authors that all potential conflicts of interests have been disclosed.

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