

Brief Report

Meta-analysis of Driving Cessation and Dementia: Does Sex Matter?

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Abstract

Objectives: The number of drivers with dementia is expected to increase over the coming decades. Because dementia is associated with a higher risk of crashes, driving cessation becomes inevitable as the disease progresses, but many people with dementia resist stopping to drive. This meta-analysis examines whether there are sex differences in the prevalence and incidence of driving cessation among drivers with dementia and compares the pattern of sex differences in drivers with dementia to those without dementia.

Method: MEDLINE, PsycINFO, Scopus, and CINAHL were searched in July 2015 for observational studies of sex differences in driving cessation. Meta-analyses were performed using a random-effects model.

Results: Twenty studies provided data on sex differences in driving cessation in older adults with or without dementia. Driving cessation was significantly more prevalent in women with dementia than men (odds ratio [OR] = 2.11, 95% confidence interval [CI] = 1.50–2.98), and the same pattern was found in women without dementia (OR = 2.74, 95% CI = 1.85–4.06).

Discussion: Our findings suggest that the patterns of driving cessation differ between men and women with dementia, and this may have implications for sex-specific approaches designed to support drivers with dementia both before and after driving cessation.

Keywords: Dementia—Driving—Meta-analysis—Sex differences

The number of people aged 65 and older with dementia in the United States is projected to be 13.8 million by 2050 (Hebert, Weuve, Scherr, & Evans, 2013), and the number of drivers with dementia is expected to increase as well (Carr, Shead, & Storandt, 2005). Drivers with dementia are poorer drivers (Brown & Ott, 2004) and at greater risk of crashes than cognitively normal drivers (Man-Son-Hing, Marshall, Molnar, & Wilson, 2007). Many continue to drive after a diagnosis of dementia (Herrmann et al., 2006)

not only because they rely on driving as their primary method of transportation (Kostyniuk & Shope, 2003) but also because they may lack the insight to independently decide to cease driving (Wild & Cotrell, 2003).

One important demographic characteristic known to be associated with driving cessation in the elderly adults is sex, and a systematic review (Morgan, Winter, Classen, McCarthy, & Awadzi, 2009) reported that older women are more likely to cease driving than older men.

However, sex differences with regard to drivers with dementia are inconsistent, with some studies reporting that women with dementia are more likely to cease driving than men (Herrmann et al., 2006; Seiler et al., 2012), whereas others report no sex differences (Carr et al., 2005; Mauri, Cuzzoni, Bono, Sinforiani, & Zucchella, 2014). Thus, our primary purpose was to conduct a meta-analysis to determine whether there are sex differences in driving cessation in drivers with dementia. If sex differences do exist, this may have important implications for how supportive responses are provided and optimized to men and women both before and after they stop driving. Our secondary purpose was to determine if the patterns of sex differences in driving cessation found in drivers with dementia are different to those found in older drivers without dementia.

Method

Literature Searches

A search of MEDLINE, PsycINFO, Scopus, and CINAHL was conducted in July 2015 and updated in January 2016 to identify studies of sex differences in driving cessation in people with and without dementia. Review articles and reference lists of included articles were manually reviewed to identify potentially pertinent articles.

Inclusion Criteria

The following information had to be present in each study to be included: the number of men and women drivers who did and did not cease driving; classification of participants as either having dementia or not having dementia; a description of the criteria used to determine whether participants had dementia or did not have dementia; an observational study design; and publication in English or French.

Article Screening and Data Extraction

Full-text articles agreed on by two raters (N. Baines and B. Au) were independently reviewed for adherence to inclusion criteria. Disagreements were resolved by discussion.

Quality Assessment

An eight-point quality assessment tool (Loney, Chambers, Bennett, Roberts, & Stratford, 1998) was completed by N. Baines and M. C. Tierney, and disagreements were resolved by consensus.

Statistical Analysis

Kappa was used to quantify agreement between N. Baines and B. Au about study inclusion. We conducted two meta-analyses using random-effects models, one examining sex differences in drivers with dementia and another in those without dementia using the odds ratio (OR).

We examined several moderating variables that could potentially influence the observed sex differences in driving cessation. Given that women live longer than men and aging could influence the decision to stop driving, we included driver age as a moderator. We also examined the moderating effect of Mini-Mental State Examination (MMSE) scores as degree of cognitive impairment may also have influenced driving cessation. The heterogeneity of effect sizes was measured using the Q statistic and the I^2 statistic. The Q statistic provides an estimate of whether differences between effects sizes are larger than expected by chance, and the I^2 indicates the magnitude of heterogeneity. Publication bias was assessed using Egger's test. Comprehensive Meta-Analysis v3 was used for all analyses.

Results

Summary of Studies

Fifteen unique studies met the inclusion criteria (Supplementary Figure 1). There was a high rate of agreement between the two raters (N. Baines and B. Au; $\kappa = 0.89$). The included studies are described in Supplementary Table 1.

Participants with dementia

Ten studies reported sex differences in driving cessation among participants with dementia (Gilley et al., 1991; Logsdon et al., 1992; Rees, 1995; Trobe et al., 1996; Carr et al., 2005; Herrmann et al., 2006; Burlaud et al., 2012; Seiler et al., 2012; O'Connor et al., 2013; Mauri et al. 2014). We used cross-sectional data from nine studies to estimate the prevalence of driving cessation (see Supplementary Table 1). Two of these nine studies were longitudinal, but only baseline data could be used because sex differences were not reported in their longitudinal data (Carr et al. 2005, Herrmann et al. 2006). Four of these nine studies reported that women were significantly more likely to stop driving than men (Logsdon et al. 1992; Herrmann et al. 2006; Burlaud et al., 2012; Seiler et al., 2012), whereas five studies did not find significant sex differences (Rees, 1995; Trobe et al., 1996; Carr et al., 2005; O'Connor et al., 2013; Mauri et al., 2014). When the data from the nine studies were combined in a meta-analysis to estimate prevalence, women with dementia were significantly

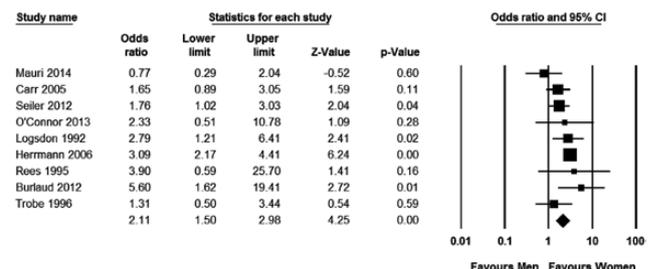


Figure 1. Forest plot, odds ratios (ORs), and 95% confidence intervals (CIs) of prevalence of sex differences in driving cessation in drivers with dementia (cross-sectional data). OR = 2.11 (95% CI = 1.50–2.98, $p = .001$, $I^2 = 40.1\%$).

Table 1. Full Meta-analysis, Sensitivity Analyses, and Subgroup Analysis of Studies of Driving Cessation in Drivers With Dementia

Analysis	Odds ratio (95% CI)	<i>Q</i>	<i>I</i> ² (%)
Full meta-analysis (<i>k</i> = 9)	2.11 (1.50–2.98)**	13.36	40.1
Sensitivity analysis			
Studies only used standardized criteria for dementia (<i>k</i> = 7)	2.30 (1.77–3.00)**	6.53	8.20
Studies only included caregiver-reported driving cessation or corroboration (<i>k</i> = 8)	2.09 (1.44–3.03)**	13.36	47.6
Quality assessment score ≥ 3 (<i>k</i> = 7)	2.05 (1.38–3.05)**	10.27*	41.6
Subgroup analysis			
North American studies only (<i>k</i> = 5)	2.37 (1.69–3.32)**	4.95	19.2
European studies only (<i>k</i> = 4)	1.99 (0.91–4.35)	6.76	55.6

Note: CI = confidence interval; *k* = number of studies. Standardized criteria for dementia were defined as Diagnostic and Statistical Manual of Mental Disorders (DSM-III or DSM-IV); National Institute of Neurological and Communicative Disorders and Stroke-Alzheimer’s Disease and Related Disorders Association (NINCDS-ADRDA); or Clinical Dementia Rating (CDR).

p* < .05, *p* < .01, ****p* < .001.

more likely to have ceased driving than men (OR = 2.11, 95% confidence interval [CI] = 1.50–2.98, *p* < .001, *Q* = 13.36, *p* = .100, *I*² = 40.1%). See Figure 1 for the forest plot. Because heterogeneity was observed (40.1%), age and performance on a mental status test were examined as potential sources of this heterogeneity. Moderator analysis, using meta-regressions, indicated no significant effects of age (*p* = .30) or MMSE scores (*p* = .59). Because studies varied in the quality of diagnostic criteria used to categorize participants as demented or not, we examined this potential influence on the outcome by conducting a sensitivity analysis, which excluded two studies that did not use standard diagnostic criteria (Burlaud et al., 2012; Mauri et al. 2014) (see Table 1). This did not affect the effect size but heterogeneity was considerably reduced. Because some studies relied on self-report of driving cessation in participants with dementia or cognitive impairment, we also performed a sensitivity analysis by removing one study that used self-reported driving cessation rather than caregiver reports (O’Connor et al., 2013), but this did not change the findings. The third sensitivity analysis removed two studies with quality scores <3 (Burlaud et al., 2012; Carr et al., 2005), with little effect on the results. Finally, because studies were conducted in two continents, which vary in the availability of alternate forms of transportation, we conducted subgroup analyses based on whether the study was conducted in North America (Logsdon et al., 1992; Trobe et al., 1996; Carr et al., 2005; Herrmann et al., 2006; O’Connor et al., 2013) or Europe (Rees, 1995; Burlaud et al., 2012; Seiler et al. 2012; Mauri et al., 2014). As can be seen in Table 1, the findings from North American studies were consistent with the overall finding, but heterogeneity was reduced. There were no sex differences in driving cessation in the European studies, and heterogeneity was increased. The one longitudinal study (Gilley et al., 1991) reported no significant sex difference (OR = 0.99, 95% CI = 0.61–1.62, *p* = .97).

Participants without dementia

Six studies reported sex differences in driving cessation among older adults who were deemed to not have

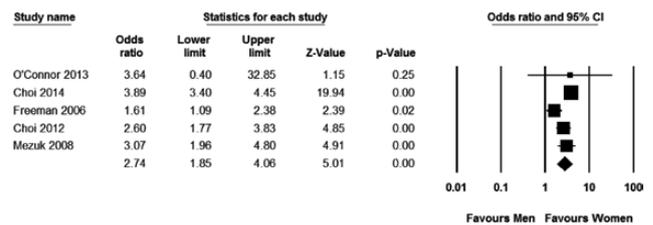


Figure 2. Forest plot, odds ratios (ORs), and 95% confidence intervals (CIs) of prevalence of sex differences in driving cessation in drivers without dementia (cross-sectional data). OR = 2.74 (95% CI = 1.85–4.06, *p* < .001, *I*² = 79.9%).

dementia based on cognitive test scores (Freeman et al., 2006; Edwards et al., 2008; Mezuk & Rebok, 2008; Choi et al., 2012; O’Connor et al., 2013; Choi et al., 2014) (see Supplementary Table 1). Of the five studies that reported cross-sectional data on sex differences, four studies reported that women were significantly more likely to stop driving than men, (Freeman et al., 2006; Mezuk & Rebok, 2008; Choi et al., 2012; Choi et al., 2014), whereas one study did not find sex differences (O’Connor et al., 2013). A meta-analysis confirmed the higher prevalence of driving cessation in women, although the result was heterogeneous (OR = 2.74, 95% CI = 1.85–4.06, *p* < .001, *I*² = 79.9%; see Figure 2 for the forest plot). Age was not a significant moderator (*p* = .32). Heterogeneity was reduced after removing one study that did not use MMSE to exclude dementia (Choi et al., 2014) (OR = 2.34, 95% CI = 1.67–3.29, *p* < .001, *I*² = 43.6). Further moderator analyses and subgroup analyses were not possible because of the small number of studies. The one longitudinal study (Edwards et al., 2008) found no significant sex differences (OR = 1.30, 95% CI = 0.90–1.88, *p* = .17).

Publication Bias

No evidence of publication bias was found in the meta-analysis of driving cessation in drivers with dementia (*p* = .29) or without dementia (*p* = .14) using Egger’s test.

Discussion

Our meta-analysis of nine cross-sectional studies indicated a more than twofold higher prevalence of driving cessation in women with dementia compared with men. No sex differences were reported in the one longitudinal study of driving cessation among participants with dementia. We also found that women without dementia were more than twice as likely to cease driving when compared with men. Again, no sex differences were found in the one longitudinal study of drivers without dementia. This meta-analysis represents the first to study sex differences in driving cessation among individuals with and without dementia. Although a previous review identified that women are more likely to cease driving than men (Morgan et al., 2009), the role of dementia was not examined.

It is of interest that dementia status did not play a role in the higher prevalence of women ceasing driving than men. Qualitative studies have suggested that men may be more likely to view their vehicle as an integral part of their identity and social status and therefore continue to drive to maintain a sense of independence (Musselwhite & Shergold, 2013). Furthermore, it should be noted that women were significantly more likely than men to have ceased driving in North America, but the effect was not statistically significant among European drivers. However, the direction and magnitude of the OR in the European studies (1.99) suggests that the nonsignificant findings may have been due to a lower statistical test power as only four studies were conducted in Europe, whereas five were conducted in North America.

Cohort effects may also be playing a role in these cross-sectional findings of sex differences. As fewer older women than men in the cohort examined in these studies held drivers' licenses, older men may be less likely to stop driving because of their role as the sole transportation option in the family, even as they develop dementia. Older women in this cohort have less driving experience, which may explain why they more frequently experience traffic-related stress and avoidance (Hakamies-Blomqvist & Wahlstrom, 1998), are less likely to engage in risk taking behaviors while driving (Brown & Ott, 2004), drive less frequently (Ross et al., 2009), and are more likely to self-regulate their driving (Wong, Smith, Sullivan, & Allan, 2016). A lower sense of confidence while driving in this older cohort of women may thus potentially lead to higher rates of driving cessation among older women than older men (Lafont, Laumon, Helmer, Dartigues, & Fabrigoule, 2008). However, as more women hold drivers' licenses and gain experience driving, they may be able to provide viable options within the family for transportation and these sex differences may not persist in younger cohorts.

Although the cross-sectional prevalence of driving cessation was higher in women than in men, the two longitudinal studies identified in this review did not find a sex difference in driving cessation over time. Both of these longitudinal studies were long-term studies, with follow-up periods of 60 (Edwards et al., 2008) and 29 months (Gilley et al., 1991). One explanation for the discrepancy in our findings of sex differences between prevalence and incidence studies

may possibly be due to sex differences in the timing and rate of driving cessation. Women in the cohort of included studies may have ceased driving at an earlier time or faster rate than men, for any number of reasons including those offered in the previous paragraph, with men driving longer but eventually stopping to drive. In longitudinal studies, this would result in sex differences evening out over time, as both groups come to stop driving. Longitudinal studies with more frequent follow-up intervals (e.g., every 6 months) would permit a more precise analysis of sex differences in driving cessation over time. However, as only two longitudinal studies were identified, further research is needed to assess sex differences in driving cessation over time in populations of older adults with and without dementia.

The conclusions that can be drawn from the results of our meta-analysis are restricted by the limitations of the included studies. The incidence of sex differences in driving cessation in adults with or without dementia could not be estimated due to the paucity of longitudinal studies. The studies of participants without dementia were limited by the fact that dementia was ruled out based on cutoff scores of mental status tests, which have limited sensitivity, resulting in possible misclassifications.

This meta-analysis is the first to demonstrate that women with dementia are more likely to cease driving than men and that this pattern of sex differences also occurs in women without dementia. Our review highlights the need for more research on the reasons for the observed sex differences, which may be due to biological sex differences as well as gender differences in roles and relationships between men and women. Longitudinal studies are also needed in order to estimate the incidence of sex differences in driving cessation in participants who have undergone diagnostic assessments to both include and exclude dementia. These longitudinal studies should also compare driving cessation in regions with different population densities and transportation options. Our findings of differences between men and women with dementia in the prevalence of driving cessation suggest that sex and gender differences may have important implications for supportive responses offered to drivers with dementia both prior to and following driving cessation.

Supplementary Material

Please visit the article online at <http://psychogerontology.oxfordjournals.org/> to view supplementary material.

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Conflict of Interest

The authors declare no conflicts of interest.

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