Overestimated Crash Risks of Young and Elderly Drivers

Q1 Jonathan J. Rolison, PhD, Salissou Moutari, PhD, Paul J. Hewson, PhD, Elizabeth Hellier, PhD

Background: Young and elderly drivers are reported to have markedly greater crash rates than drivers of other ages, but they travel less frequently and represent a minority of road users. Consequently, many crashes involving young or elderly drivers also involve drivers of middle age ranges who travel more frequently.

Purpose: To examine crash rates of young and elderly drivers, controlling for ages of all drivers involved in collisions.

Methods: A retrospective longitudinal study conducted on population-wide two-vehicle crashes reported in Great Britain from 2002 through 2010 for driver age ranges (17–20, 21–29, 30–39, 40–49, 50–59, 60–69, ≥70 years) and individual driver ages among those aged 17–20 years. Annual trips made, recorded as part of a National Travel Survey, were used to estimate trip-based driver crash rates.

Results: Crash rates of drivers aged 17–20 years were not significantly different from crash rates of drivers aged 21–29 years (rate ratio=1.14; 95% CI=0.96, 1.33) when controlling for ages of both drivers involved in two-car collisions, and drivers aged 17 years had the lowest crash rate among drivers aged 17–20 years. Crash rates of drivers aged ≥70 years equaled crash rates of drivers aged 60–69 years (rate ratio=1.00; 95% CI=0.77, 1.32) and were 1.40 times (95% CI=1.10, 1.78) lower than crash rates of drivers aged 50–59 years.

Conclusions: The current findings are in contrast with reports of high crash risks among young and elderly drivers, and suggest that previous reports may have overestimated the crash risks of these drivers by failing to control for ages of all drivers involved in collisions.
(Am J Prev Med 2013;■(■):■■■–■■■)

Introduction

In 2010, 1.24 million deaths worldwide were the result of motor vehicle crashes.[1] The WHO warns that if current trends continue, road traffic fatalities will become the fifth leading cause of death by 2030.[1] Central to concerns for road safety are younger and older drivers who are reported to have markedly greater crash rates per mile driven or per trip made than drivers of other ages.[2–5] Teenage drivers are reported to have fatal crash rates that are as much as seven times the rate of drivers aged 30–59 years,[2,3] and drivers aged ≥70 are reported to have fatal crash rates in excess of four times those of drivers in middle age ranges.[5] Policymakers have responded by proposing graduated licensing systems for teenagers to foster the development of driver experience in low-risk driving conditions.[6,7] License renewal regulations have been enforced for older adults in response to reports of high crash rates among elderly drivers,[8] and healthcare professionals are increasingly being called to assess the driving abilities of older adults.[9]

The majority of crashes that result in driver or passenger injury involve two vehicles. A total of 91,870 crashes in Great Britain in 2010 were between two vehicles, compared with 23,824 crashes involving a single vehicle and 27,460 crashes involving three or more vehicles.[10] Younger and older drivers travel less frequently than drivers of other age ranges and represent a small proportion of road users.[11] Drivers aged 17–20 years made 654 million trips in Britain in 2010, and drivers aged ≥70 years made 2.12 billion trips in the same period, compared with 2.81, 4.72, 6.22, 3.21, and 4.66 billion trips made by drivers aged 21–29, 30–39,

From the School of Psychology (Rolison), the School of Mathematics and Physics (Moutari), Queen's University Belfast, Belfast, the School of Computing and Mathematics (Hewson), and the School of Psychology (Hellier), University of Plymouth, Plymouth, United Kingdom

Address correspondence to: Jonathan J. Rolison, PhD, School of Psychology, Queen's University Belfast, Belfast BT7 1NN, UK. Email: j.rolison@qub.ac.uk.

0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2013.08.014

40–49, 50–59, and 60–69 years, respectively.[11] Thus, many crashes that involve younger and older drivers involve drivers of other age ranges who travel more frequently. Crash rates by driver age control for risk exposure (e.g., trips made) but do not control for the travel of other drivers involved in the same collision. We hypothesized that previous reports have overestimated crash rates of young and elderly drivers and underestimated crash rates of drivers of the middle age ranges by failing to control for ages of all drivers involved in multiple-car collisions.

Methods

Data Sources

For the current study, data were used on population-wide motor vehicle crashes involving two vehicles recorded in Great Britain (England, Scotland, and Wales) from Year 2002 through Year 2010, provided by the University of Essex Data Archive. The data were collected on location by police officials and include collisions involving one or more casualties. Casualties could include drivers, passengers, or pedestrians. The collision data were processed by the United Kingdom (UK) Department of Transport (DoT) before being made available for public consumption.[10] Estimated annual trip numbers by gender; driver age range (17–20, 21–29, 30–39, 40–49, 50–59, 60–69, ≥70 years); and for individual driver ages (17, 18, 19, 20 years) within the age range of 17–20 years were used to measure driver exposure, provided by the UK DoT. The trip data were collected as part of the UK National Travel Survey, for which approximately 20,000 respondents complete a 7-day travel diary to record their personal travel patterns.[11] An invitation letter to participate in the survey is sent to a random sample of individuals based on their postcode address. A member of the UK National Travel Survey then personally delivers a travel diary to each respondent's home and collects and checks the completed travel diary of each respondent. The annual response rate ranges between 55% and 60%.[12] Short journeys less than 1 km in length are excluded from the data before being made available for public consumption.

Statistical Analysis

Trip-Based Crash Rates

Generalized Poisson log-linear regression modeling was conducted on crash counts involving two vehicles. In this analysis of driver age ranges, age (17–20, 21–29, 30–39, 40–49, 50–59, 60–69, ≥70 years) was included as a factor, with year (2002–2010) as a covariate. Annual number of trips made by drivers of each age range was included as an offset term to control for driver exposure by age and to calculate trip-based crash rates. Thus, trip-based crash rates for each driver age, Age_i, equaled total crashes by trips made, such that:

$$crash\ \ rate_{Age_i} = \frac{\sum total\ \ crashes_{Age_i}}{trips_{Age_i}}. \tag{1}$$

Driver crash rates were assessed also for individual ages within the range of 17–20 years. For this analysis, driver age was categorized as 17, 18, 19, or 20 years and was included as a factor, with year (2002–2010) as a covariate. Annual number of trips made by drivers of each individual age was included as the offset term to calculate trip-based crash rates for each driver age. In addition, driver crash rates for men and women aged 17 years and older were assessed by including gender as a factor; year (2002–2010) as a covariate; and annual number of trips made by men and women aged 17 years and older as the offset term.

Crash rates by driver age control for trips made but do not control for trips made by other drivers involved in the same collisions. Exposure was controlled for by age of both drivers involved in collisions in the assessment of adjusted crash rates. In the log-linear regression model, crash counts were included by age of both drivers involved in collisions. Driver exposure by age of both drivers was calculated by computing the square root of the product of annual trips made by both driver ages involved in collisions. This was done to adjust for trips made by both drivers and was included as an offset term to measure trip-based crash rates. This meant that the age range factor (17–20, 21–29, 30–39, 40–49, 50–59, 60–69, ≥70 years) represented the trip-based crash rates of each driver age range after adjusting for exposure of both drivers involved in the collision. Thus, adjusted trip-based crash rates for each driver age, Age_i, equaled the sum of crash counts involving each other driver age, Age_j, divided by the square root of the product of trips made by both driver ages:

$$adjusted\ \ crash\ \ rate_{Age_i} = \sum_{Age_j=1}^{n} \frac{crashes_{Age_i Age_j}}{\sqrt{trips_{Age_i} \times trips_{Age_j}}}. \tag{2}$$

In the assessment of adjusted crash rates of individual ages within the range of 17–20 years, crash counts by age of both drivers involved in collisions were included. Driver age was categorized as 17, 18, 19, or 20 years. For collisions in which the other driver involved in the collision was aged older than 20 years, age was categorized as 21–29, 30–39, 40–49, 50–59, 60–69, and ≥70 years. Driver exposure, calculated as the square root of the product of annual trips made by both driver ages, was included as the offset term. Thus, adjusted crash rates for drivers aged 17, 18, 19, and 20 years were assessed after controlling for ages of both drivers involved in collisions. In the assessment of adjusted crash rates of men and women, crash counts were included by gender of both drivers involved in collisions and driver exposure was the square root of the product of annual trips made by both driver genders.

Population-Based Crash Count Estimates

Reported crash counts in the population from Year 2003 through Year 2010 were compared with crash counts estimated by crash rates of the period starting and ending 1 year earlier (2002–2009). Annual trip data for each driver age were substituted for each year in the crash rates of the previous year to estimate crash counts for the following year. Prediction error was defined as the absolute difference between reported and estimated crash counts as a proportion of reported crash counts.

Results

Trip-Based Crash Rates

Drivers aged 17–20 years had a crash rate that was 2.33 (95% CI=2.22, 2.44); 4.55 (95% CI=4.35, 4.55); and 5.88 (95% CI=5.88, 6.25) times greater than that of drivers aged 21–29, 30–39, and 40–49 years, respectively (Figure 1a; Table 1). The adjusted crash rate of drivers aged 17–20 was 1.14 (95% CI=0.96, 1.33); 1.56 (95% CI=1.32, 1.85); and 2.00 (95% CI=1.69, 2.38) times greater than that of drivers aged 21–29, 30–39, and 40–49 years, respectively (Figure 1a; Table 1). Thus, the adjusted crash rate of drivers aged 17–20 years was lower after controlling for age of both drivers involved in collisions and was not significantly different from the adjusted crash rate of drivers aged 21–29 years.

Drivers aged ≥70 years had a crash rate that was 1.28 (95% CI=1.18, 1.33) and 1.14 (95% CI=1.08, 1.19) times greater than that of drivers aged 60–69 and 50–59 years, respectively (Figure 1a; Table 1). The adjusted crash rate of drivers aged ≥70 years equaled the adjusted crash rate of drivers aged 60–69 years (rate ratio=1.00; 95% CI=0.77, 1.32) and was 1.40 times (95% CI=1.10, 1.78) lower than the adjusted crash rate of drivers aged 50–59 years (Figure 1a; Table 1). Thus, adjusted crash rates were not greater for older (i.e., ≥70) adult drivers than for other age ranges after controlling for age of both drivers involved in collisions.

Drivers aged 17 years had a crash rate that was 1.18 (95% CI=1.02, 1.33); 1.32 (95% CI=1.15, 1.50); and 1.35 (95% CI=1.19, 1.54) times greater than that of drivers aged 18, 19, and 20 years, respectively (Figure 1b; Table 1). The adjusted crash rate of drivers aged 17 years was instead 1.31 (95% CI=1.44, 1.50); 1.21 (95% CI=1.05, 1.39); and 1.21 (95% CI=1.05, 1.38) times lower than the adjusted crash rates of drivers aged 18, 19, and 20 years, such that drivers aged 17 years had the lowest crash rate among those aged 17–20 years after controlling for age of both drivers involved in collisions (Figure 1b; Table 1).

The crash rate of male drivers was 1.12 (95% CI=1.10, 1.15) times greater than for women (Table 1), and the adjusted crash rate of male drivers was 1.25 (95% CI=1.01, 1.56) times greater than for women. Thus, the adjusted crash rate of male drivers with respect to female drivers was greater after controlling for both driver genders involved in collisions as women overall made fewer trips than men (Table 1).

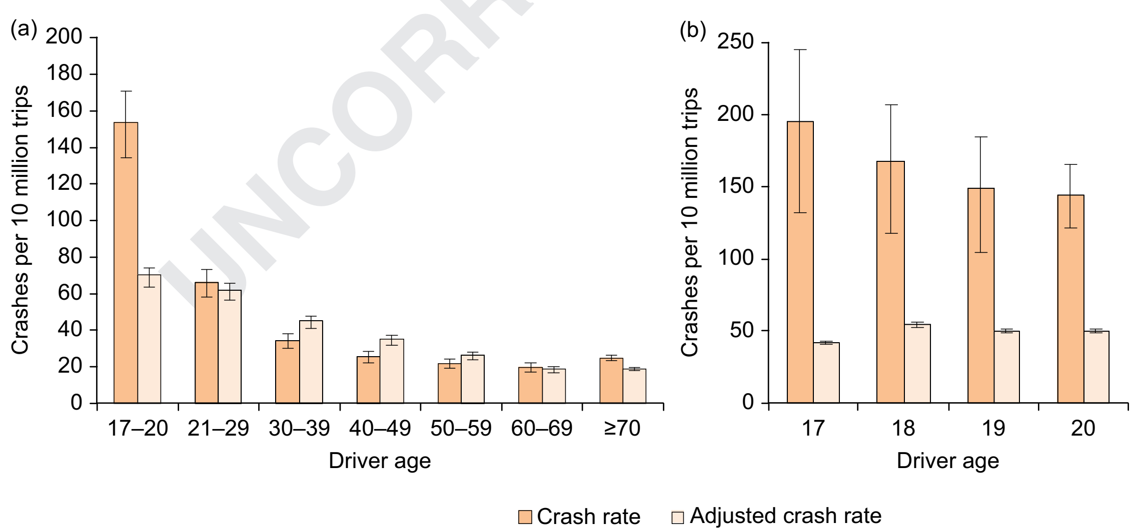

Figure 1. Crash rates and adjusted crash rates per 10 million trips by driver age for (a) driver age ranges and (b) individual driver ages in Great Britain, 2002–2010

Note: Crash rates and adjusted crash rates were calculated based on two-vehicle crashes and estimated trip numbers in Great Britain from 2002 to 2010. Crash counts and estimated trip numbers were provided by the UK Department of Transport. Estimated trip numbers were collected as part of the UK National Travel Survey. Crash rates for each driver age control for number of trips made; adjusted crash rates for each driver age control for number of trips made by both drivers involved in collisions. Error bars represent 95% CIs.

Table 1. Trip-based relative risk for crashes by driver age in Great Britain, 2002–2010

Variable	Crash counts	Trips, ×10 million	Crash rate	Adjusted crash rate	Relative risk crash rate	Relative risk adjusted crash rate
17–20 years	10,322	67.48	157.06	71.81	1.00	1.00
21–29 years	18,827	284.93	67.47	63.56	0.43 (0.41, 0.45)	0.88 (0.75, 1.04)
30–39 years	19,002	544.17	35.22	46.16	0.22 (0.22, 0.23)	0.64 (0.54, 0.76)
40–49 years	15,584	610.91	26.07	35.95	0.17 (0.16, 0.17)	0.50 (0.42, 0.59)
50–59 years	10,310	467.93	22.44	27.11	0.14 (0.14, 0.15)	0.38 (0.31, 0.46)
60–69 years	5,775	292.83	20.28	19.32	0.13 (0.12, 0.14)	0.27 (0.22, 0.34)
≥70 years	4,622	187.27	25.45	19.36	0.16 (0.15, 0.17)	0.27 (0.21, 0.34)
17 years	1,563	8.07	195.75	16.66	1.00	1.00
18 years	3,162	18.99	167.31	21.86	0.85 (0.75, 0.98)	1.31 (1.44, 1.50)
19 years	2,999	20.61	148.83	20.10	0.76 (0.67, 0.87)	1.21 (1.05, 1.39)
20 years	3,088	21.64	144.30	10.99	0.74 (0.65, 0.84)	1.21 (1.05, 1.38)
Women	28,181	1096.66	25.71	24.36	1.00	1.00
Men	39,358	1357.04	28.87	30.51	1.12 (1.10, 1.15)	1.25 (1.01, 1.56)
Overall	46,531	2455.51	18.95			

Note: Crash counts and estimated trip numbers are average annual figures from 2002 to 2010 for Great Britain supplied by the UK Department of Transport. Crash counts are population-wide motor vehicle crashes involving two vehicles and represent the total number of crashes involving a driver of each age range (21–29, 30–39, 40–49, 50–59, 60–69, and ≥70 years); individual age (17, 18, 19, and 20 years); and gender. Stratifying two-vehicle crashes (e.g., by age or gender) results in some double counting of collisions. For example, a single crash involving a driver aged 17 years and a driver aged 18 years is counted both in the crash counts of 17 years and in the crash counts of 18 years. This causes total crash counts across subgroups to vary according to the number of stratified subgroups. Estimated trip numbers were collected as part of the UK National Travel Survey. Crash rates for each driver age (or gender) control for number of trips made; adjusted crash rates for each driver age (or gender) control for number of trips made by both drivers involved in collisions. All crash rates and adjusted crash rates were estimated from the regression analyses, except the overall crash rate estimate. Figures in parentheses for relative risks indicate the 95% CIs. Relative risks for drivers aged 17–20 years, drivers aged 17 years, and women are the reference groups.

Population-Based Crash Count Estimates

Population-based crash count estimates for age ranges were more accurate overall when based on adjusted crash rates of the previous year (Figure 2a). Figure 2b shows that the prediction error for estimated crash counts was smaller for all age ranges (except drivers aged 30–39 years) when based on adjusted crash rates that controlled for ages of both drivers involved in collisions. Reductions in prediction error were largest for the youngest (17–20 years) and oldest (≥70 years) drivers (Figure 2b). Regarding individual ages, crash count estimates were more accurate for drivers aged 17, 18, 19, and 20 years when based on adjusted crash rates of the previous year (Figure 3a) and prediction error was also reduced for each driver age when based on adjusted crash rates (Figure 3b). Thus, adjusted crash rates for age ranges and individual ages were more accurate as a result of controlling for ages of both drivers involved in collisions.

Discussion

Young and elderly drivers travel less frequently than people in other age ranges and represent a minority of road users.[11] Many crashes that involve younger and older drivers as a result involve drivers of middle age ranges who travel more frequently. Crash rates control for driver exposure by age but do not control for the travel of other drivers involved in the same collision. This analysis suggests that previous reports may have overestimated crash rates of young and elderly drivers and underestimated crash rates of drivers in middle age ranges by failing to account for ages of all drivers involved in multiple-car

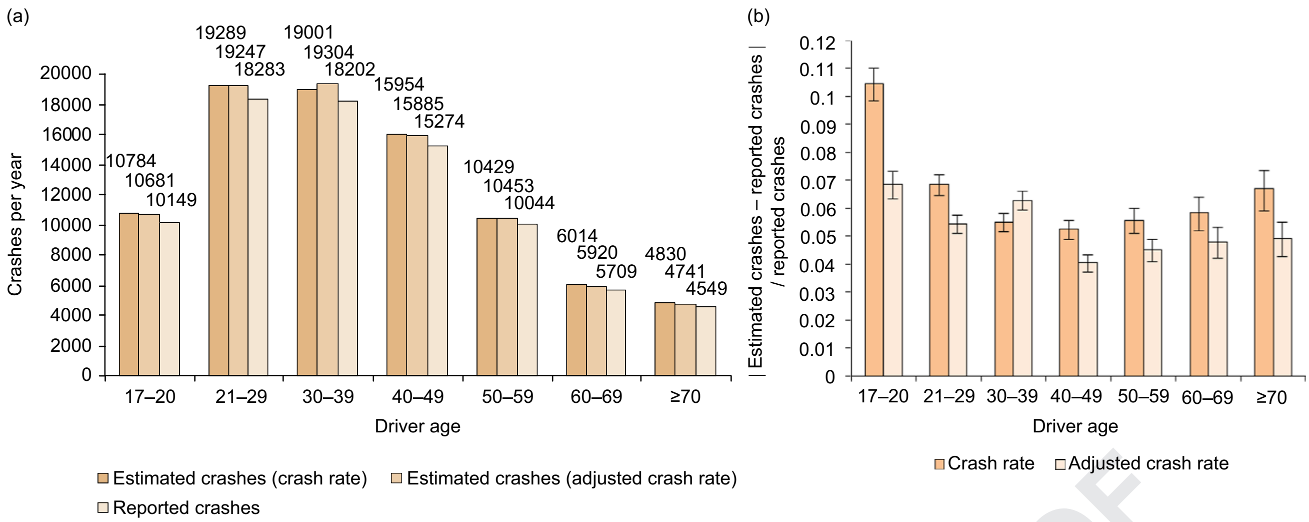

Figure 2. (a) Estimated crash counts and (b) prediction error based on crash rates and adjusted crash rates of the previous year in Great Britain, 2003–2010

Note: (a) Annual trip data were substituted in the crash rates and adjusted crash rates of the previous year to estimate crash counts for the following year in Great Britain from 2003 through 2010. (b) Prediction error is the absolute difference between reported and estimated crash counts as a proportion of reported crash counts in Great Britain from 2003 through 2010. Crash rates for each driver age control for number of trips made; adjusted crash rates for each driver age control for number of trips made by both drivers involved in collisions. Crash counts and estimated trip numbers were provided by the UK Department of Transport. Error bars represent 95% CIs.

collisions (Figure 1). Further, estimates of crash counts in the population were more accurate when based on adjusted crash rates of the previous year that controlled for ages of all drivers involved in collisions (Figures 2 and 3).

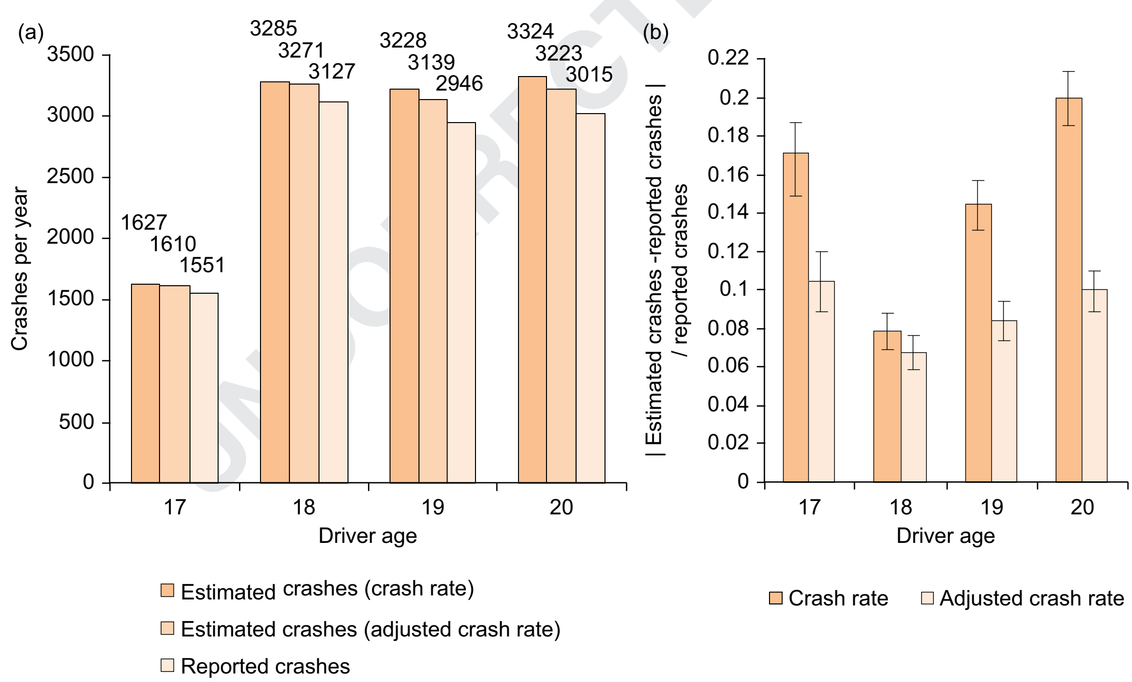

Figure 3. (a) Estimated crash counts and (b) prediction error based on crash rates and adjusted crash rates of the previous year in Great Britain, 2003–2010

Note: (a) Annual trip data were substituted in the crash rates and adjusted crash rates of the previous year to estimate crash counts for the following year in Great Britain from 2003 to 2010. (b) Prediction error is the absolute difference between reported and estimated crash counts as a proportion of reported crash counts in Great Britain from 2003 to 2010. Crash rates for each driver age control for number of trips made; adjusted crash rates for each driver age control for number of trips made by both drivers involved in collisions. Crash counts and estimated trip numbers were provided by the UK Department of Transport. Error bars represent 95% CIs.

Policymakers around the world have responded to reports of high crash rates among young drivers by recommending graduated licensing systems and educational interventions for teenagers to encourage the development of driver skill.[6,7] The current study shows that crash rates of young drivers may have been overestimated in previous reports. Adjusted crash rates of drivers aged 17–20 years did not differ significantly from the adjusted crash rate of drivers aged 21–29 years (Figure 1a) and were lowest for drivers aged 17 years among drivers aged 17–20 years (Figure 1b). In Great Britain, youngest drivers are charged a high premium according to the engine capacity of their vehicle, which restricts youngest drivers to lower-performance cars.[13] Crash risks are linked to driving speed,[14] suggesting that insurance restrictions may reduce crash risks among youngest drivers. Adjusted crash rates reduced smoothly across age ranges (Figure 1a), indicating that driver skill may develop more gradually than currently believed. We recommend that in addition to promoting policies that target young drivers, policymakers should consider the benefits of prolonged driver training initiatives, such as advanced driver training courses and further driver assessments for developing driver skill.

License renewal regulations for older adults have been tightened by policymakers in response to reports of high crash rates among elderly drivers.[8] The American Medical Association now encourages physicians to screen older adults for cognitive and visual impairment that might affect driver safety,[15] charging medical practitioners with difficult decisions about the driving privileges of older adults.[9] Age-based testing discourages unimpaired elderly drivers from renewing their driver license,[16] which compromises mobility with direct effects on well-being and multiple health outcomes.[17] These results show that adjusted crash rates were not greater for elderly drivers, which signifies that the strong emphasis on license renewal regulations and screening of older adults may be misplaced. Adjusted crash rates for drivers aged ≥70 years equaled those of drivers aged 60–69 years and were lower than the adjusted crash rates of drivers aged 50–59 years (Figure 1a).

In Great Britain, 83% of car crashes in 2010 involved two or more vehicles.[10] Failure to control for ages of all drivers involved in collisions in previous studies may have biased estimates of driver crash rates. Biases in crash rate estimates can occur whenever drivers involved in multiple car collisions differ in their travel patterns. Women make fewer trips than men each year as drivers, and as a result, the crash rate of female drivers was lower with respect to male drivers after controlling for both driver genders involved in collisions.

The present study has a number of limitations. First, the measures of exposure were based on annual trips made by drivers and controlled for neither the length of journey nor the nature of trips made (e.g., leisure, work commute), for which there may be systematic differences with age. Second, in the analysis of two-vehicle collisions, the data did not account for which driver was most likely at fault. Skill level, inexperience, and risk-taking behaviors are associated with increased crash risks among younger drivers,[3,4] and cognitive limitations and visual impairment have been linked to driver error in older age.[18] Age differences in the degree to which drivers are the cause of their collisions may have affected the age comparisons. Third, the reliability of crash data used in the current study depends on crashes being accurately reported by police officials, and the reliability of the exposure data depend on respondents to a national travel survey accurately recording their personal travel patterns. Any inaccuracies in these data, however, should not have differed systematically with age or gender of the driver and thus should not have affected the main findings. The data used in this current analysis represent the most accurate road safety data available in Great Britain.

The current findings suggest that previous reports may have overestimated the crash rates of young and elderly drivers by failing to account for ages of all drivers involved in multiple-car collisions. The focus of the current investigation was on two-vehicle crashes in Great Britain over a 9-year period (Years 2002–2010). Before strong claims can be made about the generality and robustness of these findings, further investigations are needed to assess adjusted crash rates in other countries that adopt different road safety policies. The current research investigated all two-vehicle crashes involving at least one casualty; it is important to further demonstrate that these findings can be replicated for both fatal and nonfatal driver casualties.

We thank Frank Kee for helpful comments on an earlier draft of the article.

No financial disclosures were reported by the authors of this paper.

References

1. World Health Organization. Global Status Report on Road Safety, 2013. www.who.int/violence_injury_prevention/road_safety_status/2013/report/en/index.html.
2. Williams AF. Teenage drivers: patterns of risk. J Saf Res 2003;34:5–15.
3. Rolison JJ, Hewson PJ, Hellier E, Hurst L. Risks of high-powered motorcycles among younger adults. Am J Public Health 2013;103:568–71.
4. Shope JT, Bingham CR. Teenage driving: motor-vehicle crashes and factors that contribute. Am J Prev Med 2008;35:261–71.

5. Rolison JJ, Hewson PJ, Hellier E, Husband P. Risk of fatal injury in older adult drivers, passengers, and pedestrians. J Am Geriatr Soc 2012;60:1504–8.
6. Chen L-H, Baker SP, Guohua L. Graduated driver licensing programs and fatal crashes of 16-year-old drivers: a national evaluation. Pediatrics 2006;118:56–62.
7. Masten SV, Foss RD, Marshall SW. Graduated driver licensing and fatal crashes involving 16- to 19-year-old drivers. JAMA 2011;306:1098–103.
8. Grabowski DC, Campbell CM, Morrisey MA. Elderly license laws and motor vehicle fatalities. JAMA 2004;291:2840–6.
9. Carr DB, Ott BR. The older driver with cognitive impairment: it's a frustrating life. JAMA 2010;303:1632–41.
10. Department for Transport. Reported Road Casualties Great Britain, 2010. assets.dft.gov.uk/statistics/releases/road-accidents-and-safety-annual-report-2010/rrcgb2010-complete.pdf.
11. Department for Transport. National Travel Survey, 2010. www.gov.uk/government/uploads/system/uploads/attachment_data/file/8932/nts2010-01.pdf.
12. Department for Transport. National Travel Survey 2010: Technical Report. assets.dft.gov.uk/statistics/series/national-travel-survey/nts2010-technical.pdf.
13. The AA. Car insurance groups. www.theaa.com/insurance/car-insurance-groups.html.
14. Aarsts L, van Schagen I. Driving speed and the risk of road crashes: a review. Accid Anal Prev 2006;38:215–24.
15. Physician's Guide to Assessing and Counseling Older Drivers, 3rd edition. American Medical Association, 2010.
16. Ross LA, Browning C, Luszcz MA, et al. Age-based testing for driver's license renewal: potential implications for older Australians. J Am Geriatr Soc 2011;59:281–5.
17. Oxley J, Whelan M. It cannot be all about safety: the benefits of prolonged mobility. Traffic Inj Prev 2008;9:367–78.
18. Anstey KJ, Wood J, Lord S, et al. Cognitive, sensory, and physical factors enabling driving safety in older adults. Clin Psychol Rev 2005;25:45–65.