The relationship between gasoline price and patterns of motorcycle fatalities and injuries

He Zhu, Fernando A Wilson, Jim P Stimpson

▸ Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/injuryprev-2014-041314).

Department of Health Services Research and Administration, College of Public Health, University of Nebraska Medical Center, Omaha, Nebraska, USA

Correspondence to
He Zhu, College of Public Health, University of Nebraska Medical Center, 984350 Nebraska Medical Center, Omaha, NE 68198-4350, USA; he.zhu@unmc.edu

Received 26 May 2014
Revised 5 October 2014
Accepted 6 October 2014
Published Online First 15 December 2014

ABSTRACT

Objective Economic factors such as rising gasoline prices may contribute to the crash trends by shaping individuals' choices of transportation modalities. This study examines the relationship of gasoline prices with fatal and non-fatal motorcycle injuries.

Methods Data on fatal and non-fatal motorcycle injuries come from California's Statewide Integrated Traffic Records System for 2002–2011. Autoregressive integrated moving average (ARIMA) regressions were used to estimate the impact of inflation-adjusted gasoline price per gallon on trends of motorcycle injuries.

Results Motorcycle fatalities and severe and minor injuries in California were highly correlated with increasing gasoline prices from 2002 to 2011 (r=0.76, 0.88 and 0.85, respectively). In 2008, the number of fatalities and injuries reached 13 457—a 34% increase since 2002, a time period in which inflation-adjusted gasoline prices increased about $0.30 per gallon every year. The majority of motorcycle riders involved in crashes were male (92.5%), middle-aged (46.2%) and non-Hispanic white (67.9%). Using ARIMA modelling, we estimated that rising gasoline prices resulted in an additional 800 fatalities and 10 290 injuries from 2002 to 2011 in California.

Conclusions Our findings suggest that increasing gasoline prices led to more motorcycle riders on the roads and, consequently, more injuries. Aside from mandatory helmet laws and their enforcement, other strategies may include raising risk awareness of motorcyclists and investment in public transportation as an alternative transportation modality to motorcycling. In addition, universally mandated training courses and strict licensing tests of riding skills should be emphasised to help reduce the motorcycle fatal and non-fatal injuries.

INTRODUCTION

The CDC identified the large decline in MVC-related deaths as one of the 10 great public health achievements in the USA in the first decade of the 21st century.[1] However, over the same time period, the number of motorcycle-related deaths and injuries increased by more than 40%.[2] According to the National Highway Traffic Safety Administration, there were over 4500 motorcycle-related deaths in 2010, accounting for 14% of all motor vehicle fatalities, compared with about 3200 motorcycle-related deaths in 2001, accounting for 7.5% of all motor vehicle fatalities.[2] This increase in fatalities is particularly striking given that motorcycles account for only 3% of all registered vehicles in the USA.[2 3] Moreover, the impact of motorcycle crashes is felt across a wide range of demographic groups, particularly young riders.[4]

Economic factors have been identified as a major driver of travel behaviour and traffic safety.[5–7] For example, fluctuating gasoline prices may affect consumers' choice of travel mode, causing them to choose vehicles with greater fuel economy such as motorcycles, which typically operate with up to 70% lower fuel cost than cars.[8–11] People may choose to save money by travelling on motorcycles rather than in cars despite the potential for motorcycles to increase the risk of a fatal or severe injury crash.[12] Since the 1980s, it has been observed that motorcycle registrations in the USA are positively correlated with gasoline prices and, in turn, that motorcyclist fatalities are positively associated with the number of motorcycle registrations.[13] However, information about non-fatal motorcycle injuries is scarce, even though the number of non-fatal motorcycle injuries is estimated to be 20 times higher than the number of fatal injuries, which is important given the large healthcare costs associated with injuries.[2 14–17] There is also a need for data on the characteristics of motorcycle riders to target the determinants of motorcycle crashes. Furthermore, in recent years, gasoline prices varied significantly across states and local areas, which could indicate the need for more targeted strategies to reduce motorcycle crashes.[18]

Thus, this study focuses on the relationship between gasoline prices and motorcycle fatalities and non-fatal injuries in California. We focus on California because it has the highest number of motorcycle registrations in the USA and ranks third in number of motorcycle crashes, accounting for 8% of all fatalities and 13% of injuries from motorcycle crashes in the USA.[2 3 19] In addition, gasoline prices in California are representative of prices across the country.[18] Furthermore, available data from California administrative records provide detailed information on both the crash and riders.[20] Finally, California's early adoption of the universal helmet law mitigates research design issues with confounding.[21]

METHODS

Data on motorcycle-related fatalities and injuries were obtained from California's Statewide Integrated Traffic Records System (SWITRS), which is maintained by the California Highway Patrol Information Services Unit.[22] SWITRS includes individual-level records of fatal, injury and property damage-only crashes occurring on California's state highways and all other roadways (private property excluded) that were reported to the police.[22 23] The data report characteristics of crashes, crash-related roadway users and vehicles. The study period is 2002–2011. Data prior to 2002 are not

To cite: Zhu H, Wilson FA, Stimpson JP. *Inj Prev* 2015;**21**:153–158.

directly comparable with more recent data due to a change in methodology.[20 23] Also, after 2002, property damage-only crashes were not consistently reported by the various agencies throughout the state.[23] Therefore, in this study, we focus on fatal and non-fatal injury crashes for 2002–2011. SWITRS also provides information on the number of registered motorcycles and population.[19]

A motorcycle-related crash is defined as an MVC involving at least one motorcycle. The number of fatalities in a motorcycle-related crash includes victims who succumbed to their injuries within 30 days postcrash; the number of severe injuries includes severely injured victims who were no longer able to walk, drive or perform activities as they had before the crash; and the number of minor injuries includes both visible injuries (other than severe) and symptoms of pain. The severity of injuries and their number are recorded in police reports and provided in SWITRS data. Injured victims may be motorcycle occupants, passenger car occupants or pedestrians and other road users; however, about 90% of injured victims were motorcycle riders or their passengers.[22] Outcome variables are monthly number of fatalities, severe and minor injuries in motorcycle-related crashes, which were aggregated from individual crash records in California. We also computed rates per million population for fatalities, severe injuries and minor injuries associated with motorcycle-related crashes.

Gasoline price per gallon data were provided by the US Energy Information Administration (EIA), which monitors retail gasoline prices nationwide and regionally, including California.[18] EIA collects retail gasoline prices for all grades by telephone from a sample of approximately 800 retail gasoline outlets (self-serve) every week. Weekly, monthly and annual price data are calculated using weighted average prices at city, state, regional and national levels based on sales and delivery volume.[18] We examined monthly average retail gasoline price per gallon of all grades for the state of California, including all taxes. Prices were adjusted to 2011 dollars using the Consumer Price Index.[24]

We describe trends in inflation-adjusted gasoline prices and number of motorcycle-related fatalities and injuries as well as characteristics of motorcycle crashes and riders. Autoregressive integrated moving average (ARIMA) time-series models are used to estimate the association of inflation-adjusted gasoline prices with motorcycle-related fatalities, severe injuries and minor injuries using monthly data from 2002 to 2011 for California. ARIMA modelling is a widely used time-series methodology due to its flexibility and simplicity in analysing non-stationary data.[25] Our data exhibit temporal trends with substantial month-to-month or seasonal variation. The ARIMA model allows us to de-trend and adjust for seasonality in the data, thus, identifying the empirical relationship between gasoline prices and our crash outcomes. The ARIMA model is operationalised as ARIMA(p,d,q), where p is the number of autoregressive terms, d is the number of differences and q is the number of moving average terms. Values for the parameters p, d and q were identified by checking the data for stationarity and examining the correlograms of the predicted outcomes from the model (see online supplementary appendix table A2).

RESULTS

Figure 1 describes the annual number of motorcycle registrations and inflation-adjusted gasoline prices from 2002 to 2011. Motorcycle registration closely tracked gasoline prices, with a correlation of 0.90. From 2002 to 2008, both motorcycle registration and gasoline prices followed linear trends; registration numbers averaged annual increases of 48 000 while gasoline prices increased about $0.30 per gallon every year. After 2008, gasoline prices decreased, but recovered to more than $3.00 per gallon by 2011. Motorcycle registrations also decreased in 2008 before increasing gradually in 2010 and 2011.

Figure 2 illustrates the relationship of trends in motorcycle fatalities and injuries with inflation-adjusted gasoline prices over time. Similar to figure 1, the number of fatalities and injuries followed trends in gasoline prices. Fatalities and injuries reached 13 457 in 2008, up from 10 067 in 2002—a 34% increase. Fatal and severe injuries accounted for 25% of this increase. More detailed information by injury level can be found in online supplementary appendix table A1. Total numbers of injuries and injury rates per capita were strongly related to gasoline prices. Gasoline prices were correlated at 0.76 for motorcycle fatalities, 0.88 for severe injuries and 0.85 for minor injuries (correlations for injury rates were similar). The number of severe injuries was five times higher than the number of fatalities, and minor injuries were more than 20 times higher. Furthermore, besides the increasing numbers and rates, the shares of fatalities and severe and minor injuries in total MVCs almost doubled in the 10-year study period.

Figure 3 shows annual inflation-adjusted gasoline prices and percentages of motorcycle-related fatalities and severe injuries out of all motor vehicle fatalities and injuries, respectively. These percentages steadily increased as gasoline prices increased from 2002 to 2008, a 100% increase for fatalities and 60% increase for severe injuries. After 2008, the share of fatalities decreased somewhat, and the share of severe injuries remained stable.

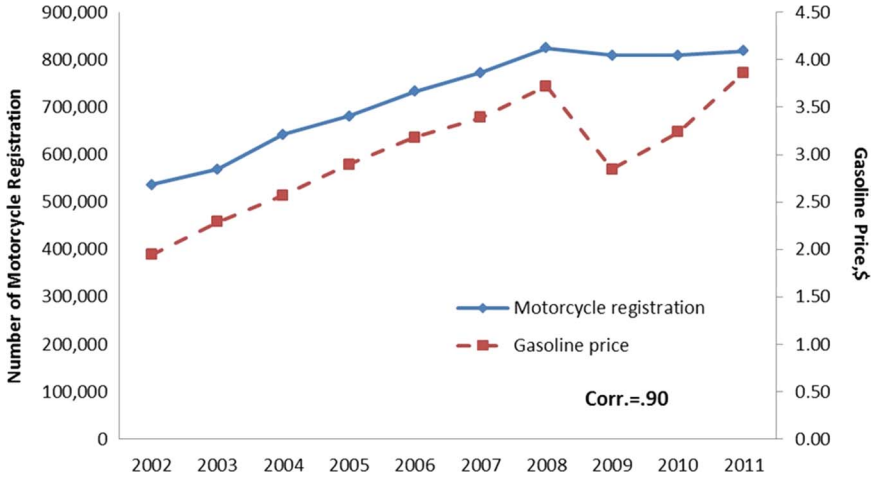

Figure 1 Inflation-adjusted price of gasoline and number of motorcycle Registrations: California, 2002–2011.

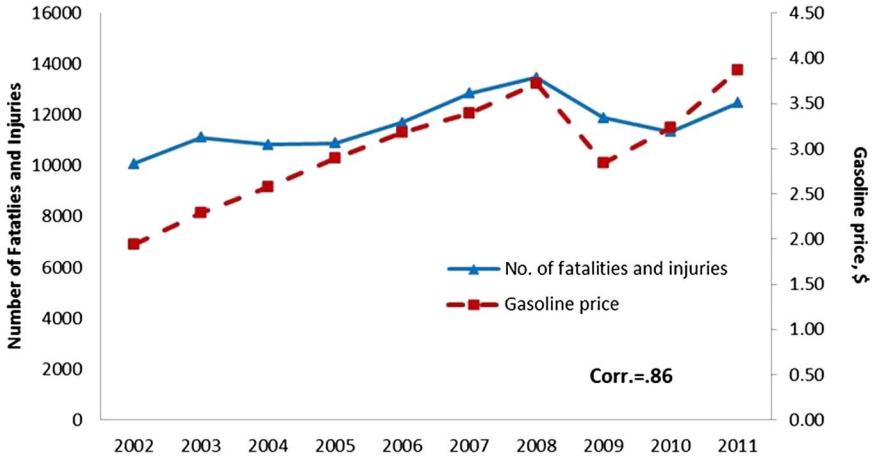

Figure 2 Inflation-adjusted price of gasoline and number of fatalities and injuries from motorcycle-related crashes: California, 2002–2011.

The above results show strong positive correlations and similar trends for motorcycle fatalities and injuries with inflation-adjusted gasoline prices. In table 1, we characterise the motorcycle riders involved in these crashes including sex, age, race/ethnicity, insurance status, model year of the motorcycle and crash location, time and type. The majority of motorcycle riders involved in crashes were men (92.5%), middle-aged (46.2%) and non-Hispanic white (67.9%). These groups also accounted for similar proportions among the number of riders determined to be at fault by police investigators. Also, riders aged 16–24 years, without motorcycle insurance and riding late-year models (1 year or less) accounted for a higher share of at-fault crashes than overall crashes. In addition, over 40% of motorcycle-related crashes in which the rider was at fault took place on rural roads. More crashes occurred on weekdays (Monday to Friday) and during the afternoon (12:00–17:59). Most crashes occurred because riders overturned or were broadsided (or caused a broadsided crash).

Finally, we used ARIMA regression models to predict the impact of changing gasoline prices on fatal, severe and minor injuries (table 2). Compared with the historical average of $2.99 per gallon, a rise in gasoline prices to $4.00 would have resulted in 81 more fatalities, 229 more severe injuries and 835 more minor injuries annually in California. Moreover, the regression analysis suggests that the number of fatal, severe and minor injuries would have decreased by 800, 2150 and 8140, respectively, in the period 2002–2011 if gasoline prices had remained at $2.00 per gallon in 2002. (Refer to online supplementary appendix table A2 for ARIMA model coefficients.)

DISCUSSION

Over the past decade, improvements in the road and policy environments and in car safety technologies have contributed to historic declines in motor vehicle fatalities[26–28]; however, motorcycle-related fatalities have lagged behind this trend and increasingly account for a higher proportion of total motor vehicle fatalities. Our results show that gasoline price was highly correlated with motorcycle-related fatalities and with severe and minor motorcycle-related injuries. Motorcycle riders aged 16–24 years, without motorcycle insurance or riding late-year models (1 year or less) accounted for a higher share of at-fault crashes. Our findings suggest that increasing gasoline prices leads to more motorcycle riders on the road, and, consequently, more fatal and non-fatal crash injuries.

Riding a motorcycle can be more dangerous than driving a passenger car; however, motorcycles usually are more economical, with fuel consumption averaging one-half to one-third that of passenger cars.[29] In response to ongoing elevated gasoline prices, people may be encouraged to ride motorcycles as a transportation modality. According to the 2009 National Household Travel Survey, it was estimated that about 40% of drivers most concerned price of travel (gasoline price, fee and tolls), which ranked No. 1 concern issue when people chose the transportation.[30] In California, 3.5% of the population in 2011 held

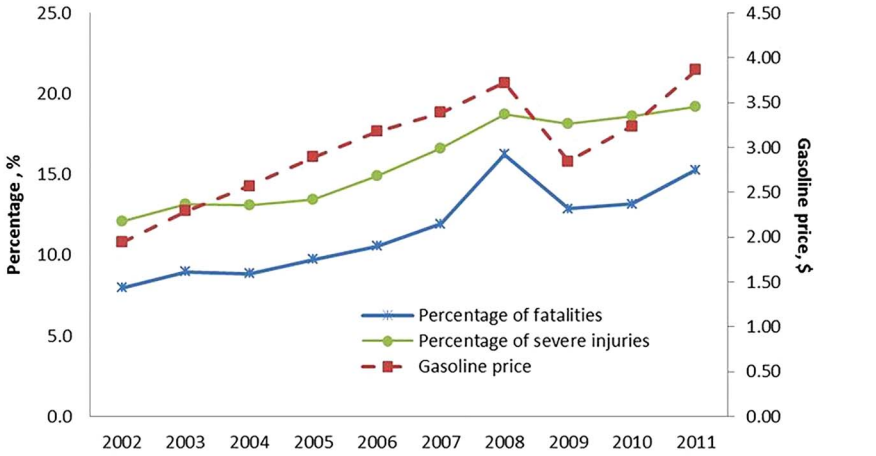

Figure 3 Inflation-adjusted price of gasoline and percentages of motorcycle-related fatalities and severe injuries in total MVCs*: California, 2002–2011.

* Percentage of motorcycle-related fatalities and severe injuries out of all motor vehicle fatalities and injuries, respectively.

Table 1 Characteristics of riders and crashes from motorcycle-related crashes: California, 2002–2011

	Overall		Rider at fault	
	No.	Per cent	No.	Per cent
Rider characteristics				
Rider sex				
Female	7633	7.5	4525	7.8
Male	94 679	92.5	53 740	92.2
Rider age (years)				
16–24	21 724	21.4	13 788	24.0
25–44	46 812	46.2	25 282	44.0
45–64	30 019	29.6	16 640	29.0
65+	2845	2.8	1757	3.0
Rider race/ethnicity				
Asian	3911	3.9	2256	4.0
Non-Hispanic black	7131	7.2	3944	7.0
Non-Hispanic white	67 327	67.9	38 737	68.3
Hispanic	16 770	16.9	9452	16.7
Other	3965	4.0	2316	4.1
Motorcycle insurance status				
Yes	73 348	78.9	39 034	73.8
No	19 580	21.1	13 888	26.2
Motorcycle model age (years)*				
<1 year	13 326	13.3	8082	14.2
1–3	26 255	26.1	14 845	26.0
>3	60 914	60.6	34 096	59.8
Crash characteristics				
Location of crash				
Rural	37 639	36.9	27 571	46.1
Non-metro	9774	9.6	5160	8.6
Metro	54 619	53.5	27 044	45.2
Day of crash				
Weekday	66 793	65.4	35 941	60.1
Weekend	35 304	34.6	23 871	39.9
Time of crash				
00:00–05:59	4929	4.8	3 174	5.3
06:00–11:59	23 820	23.4	13 694	23.0
12:00–17:59	49 459	48.5	29 460	49.4
06:00–23:59	23 705	23.3	13 349	22.4
Type of crash				
Head-on	4242	4.2	2083	3.5
Sideswipe	14 389	14.2	5709	9.6
Rear end	15 697	15.5	9485	16.0
Broadside	21 620	21.4	6289	10.6
Hit object	14 894	14.7	12 520	21.1
Overturned	23 702	23.4	20 097	33.9
Others	6651	6.6	3190	5.4

*Difference in motorcycle model year and year of crash.

Table 2 ARIMA regression-predicted impact of inflation-adjusted gasoline prices on motorcycle fatalities and injuries: California, 2002–2011

	Number of annual fatalities	Number of annual severe injuries	Number of annual minor injuries
Actual (mean= $2.99)	415	1922	9321
$2.00	335	1707	8507
$2.50	376	1817	8920
$3.00	415	1928	9332
$3.50	455	2039	9743
$4.00	496	2151	10 156

ARIMA, autoregressive integrated moving average.

motorcycle licenses compared with only 2.7% in 2002, and the number of licensed motorcycle drivers almost increased every year from 2002 to 2011, rising by 40%.[19] In fact, we present evidence that motorcycle registrations almost increased by 53% over the same time period, an increase that is strongly correlated with trends in gasoline prices. As a result, more riders—particularly inexperienced or untrained riders—are exposed to significantly higher risk of injury or death from motorcycle crashes. Our study results imply that more people will start to ride motorcycles or ride more frequently if gasoline prices remain high, resulting in higher numbers of fatal and non-fatal injuries from motorcycle crashes.

Additionally, several other reasons may contribute to the modal shift away from cars towards motorcycles. First of all, a motorcycle usually costs less than a passenger car. According to the Motorcycle Industry Council, the average price for an on-highway motorcycle was $5612 in 2009.[31] In comparison, the average transaction price of a passenger car was almost $30 000.[32] Second, increasing disposable income may be another factor to increase motorcycle sales. From 2002 to 2011, the US inflation-adjusted disposable income per capita increased from $32 733 to $36 463, despite the recession in this period.[33] Increasing road congestion problems may also attract more people to ride motorcycles as a way to save travel time. For example, lane splitting for motorcyclists is allowed in California. The above factors may work in concert with rising gasoline prices to substantially increase people's incentives to consider motorcycling as a reasonable alternative to driving. More research is needed to further characterise the role of individual preferences for motorcycling, disposable income, the impact of congestion and other factors in shaping the demand for motorcycling.

The gasoline market is complex and tied to the global economy and the political environment.[34 35] Thus, sustaining lower gasoline prices may not be a practical or desirable policy solution. Furthermore, the relationship between gasoline prices and all motor vehicle fatalities is negative.[36 37] Therefore, within an environment of sustained high gasoline prices, several traffic policies are recommended to improve motorcycle safety.[4 9 12] Universal helmet laws, which require all motorcycle riders and passengers of all ages to wear a helmet whenever riding,[21] have been determined to be a reliable and effective policy to reduce fatalities and injuries from crashes.[38–40] California's universal helmet law, in place since 1992, has been shown to be effective in improving motorcycle safety.[41] In fact, more than 97% of motorcycle riders and passengers involved in crashes in California use helmets.[2 22]

Increasing transportation options such as public transportation may decrease incentives to rely on motorcycling to lower fuel costs. Several previous studies have found that people shift to public transit in response to increasing gasoline prices.[8–10] However, the availability and capacity issues of public transit may reduce its utility as a viable alternative to motorcycling for many people. The American Public Transportation Association reported that 39% of transit agencies experience overcrowded conditions, and, in many cases, public transit may not operate during nighttime hours or on weekends.[8] Our data suggest that there were increasing trends of motorcycle injuries in rural areas

and on weekends, places and times when access to public transportation may be problematic.

Similarly, increasing risk awareness of both riders and drivers through driver education and motorcycle training may be beneficial in reducing risks from motorcycling. For example, prior research suggests that drivers are less likely to notice motorcyclists on roadways if they are not conditioned to look out for them.[13 42] In addition, our results imply that a significant fraction of riders involved in crashes were young or inexperienced riders. Thus, mandatory training may be effective. In California, although motorcycle training such as *RiderCourse* is widely available, these courses can be waived by taking a motorcycle riding test if the rider is over 21 years old.[43 44] We also found that rural areas in California have the highest numbers of fatalities and severe injuries in motorcycle-related crashes. It is unclear whether this result is due to differences in law enforcement resources, speed limits or other factors, and more research is needed in this area.

This study has several limitations. First, we focused only on California. Although our results are consistent with previous studies, further research is needed to extend this analysis to other states with comparable data in order to improve generalisability.[14 15] Second, the injury levels of victims in a motorcycle-related crash were determined by police investigators and not by medical personnel; thus, potential misclassification error may exist. Furthermore, we have no data on individual motivations to ride motorcycles (eg, riding for leisure or commuting), and thus it is not possible to determine the extent to which rising gasoline prices result in changing patterns of commuting or non-commuting trips. Although average motorcycle prices are less than average transaction prices for automobiles as discussed above, there is nevertheless significant variation in motorcycle prices with certain models priced substantially higher than many cars. Finally, omitted factors, such as climate, may affect the relationship between gasoline prices and motorcycle crash outcomes.

In conclusion, fatal and non-fatal motorcycle injuries have increased substantially in recent years. Our study suggests that this increase is associated with higher gasoline prices, resulting in more riders on public roads. Besides mandatory helmet laws, other strategies that may reduce motorcycle injuries include rising risk awareness of motorcyclists and investment in public transportation as an alternative transportation modality to motorcycling. In addition, universally mandated training courses and strict licensing tests of riding skills should be emphasised.

What is already known on the subject

- Increasing gasoline prices affects consumer's choice of travel mode, causing them to choose vehicles with greater fuel economy such as motorcycles.
- Several studies have found that motorcyclist fatalities were positively associated with increasing gasoline prices.

What this study adds

- Gasoline price was highly correlated with motorcycle-related fatalities and with severe and minor motorcycle-related injuries.
- Motorcycle riders aged 16–24 years, without motorcycle insurance or riding late-year models (1 year or less) accounted for a higher share of at-fault crashes.
- Our findings suggest that increasing gasoline prices leads to more motorcycle riders on the road, especially inexperienced riders and, consequently, more injuries.

Contributors All authors have contributed significantly to design the study, analyse the data, interpret the results and compose the manuscript.

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 Centers for Disease Control and Prevention. Ten great public health achievements—United States, 2001–2010. *MMWR Morb Mortal Wkly Rep* 2011;60:619.
2 National Highway Traffic Safety Administration. *Traffic safety facts, 2011: motorcycles*. Washington, DC: National Highway Traffic Safety Administration, US Department of Transportation, 2013.
3 Federal Highway Administration. *Highway statistics series: 2001–2011*. Washington, DC: Federal Highway Administration, US Department of Transportation, 2001–2011.
4 Centers for Disease Control and Prevention. *Motorcycle safety guide*. Atlanta, GA: Centers for Disease Control and Prevention, US Department of Health and Human Services, 2012.
5 Kopits E, Cropper M. Traffic fatalities and economic growth. *Accid Anal Prev* 2005;37:169–78.
6 Law TH, Noland RB, Evans AW. Factors associated with the relationship between motorcycle deaths and economic growth. *Accid Anal Prev* 2009;41:234–40.
7 French MT, Gumus G. Macroeconomic fluctuations and motorcycle fatalities in the US. *Soc Sci Med* 2014;104:187–93.
8 American Public Transportation Association. Potential impact of gasoline price increases on U.S. public transportation ridership, 2011–2012. Published March 2011. http://www.apta.com/resources/reportsandpublications/Documents/APTA_Effect_of_Gas_Price_Increase_2011.pdf (accessed 10 Jan 2014).
9 Congressional Budget Office. Effects of gasoline prices on driving behavior and vehicle markets. Published January 2008. http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/88xx/doc8893/01-14-gasolineprices.pdf (accessed 20 Jan 2014).
10 Gillingham K. How do consumers respond to gasoline price shocks? heterogeneity in vehicle choice and driving behavior 2010. Published July 2011. http://www.yale.edu/gillingham/Gillingham_ConsumerResponseGasPrices.pdf (accessed 5 Mar 2014).
11 Environmental Protection Agency. *2008 fuel economy guide*. Washington, DC: Environmental Protection Agency, US Department of Energy, 2008.
12 Government Accountability Office. Motorcycle safety: increasing federal funding flexibility and identifying research priorities would help support states' safety efforts. Published November 2012. http://www.gao.gov/assets/660/650037.pdf. (accessed 5 Mar 2014).
13 Hedlund J. Motorcyclist traffic fatalities by state: 2012 preliminary data. Published April 2013. http://www.ghsa.org/html/publications/pdf/spotlights/motorcycles_2012.pdf (accessed Jul 2012).
14 Hyatt E, Griffin R, Rue LW III, *et al*. The association between price of regular-grade gasoline and injury and mortality rates among occupants involved in motorcycle-and automobile-related motor vehicle collisions. *Accid Anal Prev* 2009;41:1075–9.
15 Wilson FA, Stimpson JP, Hilsenrath PE. Gasoline prices and their relationship to rising motorcycle fatalities, 1990–2007. *Am J Public Health* 2009;99:1753–8.
16 Naumann RB, Dellinger AM, Zaloshnja E, *et al*. Incidence and total lifetime costs of motor vehicle–related fatal and nonfatal injury by road user type, United States, 2005. *Traffic Inj Prev* 2010;11:353–60.
17 Ankarath S, Giannoudis PV, Barlow I, *et al*. Injury patterns associated with mortality following motorcycle crashes. *Injury* 2002;33:473–7.
18 Energy Information Administration. *Retail gasoline historical prices: 2002–2011*. Washington, DC: U.S. Energy Information Administration, 2002–2011.
19 California Highway Patrol. SWITRS 2011 report. http://www.chp.ca.gov/switrs/switrs2011.html (accessed 10 Oct 2013).
20 California Highway Patrol. New format for SWITRS raw data. http://www.mtc.ca.gov/planning/bicyclespedestrians/files/SWITRSFields.pdf (accessed 10 Oct 2013).
21 California Department of Motor Vehicles. Vehicle Code 27802 safety helmet regulations. Effective 1 January 1986. https://www.dmv.ca.gov/pubs/vctop/d12/vc27802.htm. (accessed 10 Oct 2013).
22 California Highway Patrol. Statewide Integrated Traffic Records System: 2002–2011. http://iswitrs.chp.ca.gov/Reports/jsp/userLogin.jsp (accessed 6 Mar 2013).
23 California Highway Patrol. Statewide Integrated Traffic Records System: Preface. http://www.chp.ca.gov/switrs/pdf/2011_Preface.pdf (accessed 6 Mar 2013).
24 Bureau of Labor Statistics. Consumer Price Index. http://www.bls.gov/cpi/ (accessed 10 Feb 2014).

25 Chatfield C. *The analysis of time series: an introduction*. Boca Raton, Florida: CRC press, 2013.
26 Wilson R. Early figures suggest number of traffic fatalities fell in 2013. *Washington Post*. 2 January 2014. http://www.washingtonpost.com/blogs/govbeat/wp/2014/01/02/early-figures-suggest-number-of-traffic-fatalities-fell-in-2013/ (accessed 20 Sep 2014).
27 White JB. Why driving a car has never been safer. *Wall Street Journal*. 21 October 2009. http://online.wsj.com/articles/SB10001424052748703816204574483730305881484 (accessed 20 Sep 2014).
28 Kopits E, Cropper M. Why have traffic fatalities declined in industrialised countries?: Implications for pedestrians and vehicle occupants. *J Transport Econ Policy* 2008;42:129–54.
29 Office of Highway Policy Information. Highway statistics 2011. http://www.fhwa.dot.gov/policyinformation/statistics/2011/ (accessed 7 Feb 2014).
30 National Household Travel Survey. http://nhts.ornl.gov (accessed 31 Aug 2014).
31 Motorcycle Industry Council. *Motorcycle statistical annual*. Motorcycle Industry Council. Irvine, CA; 2010.
32 Healey JR. Report: average price of new car hits record in August. *USA Today*. 5 September 2013. http://www.usatoday.com/story/money/cars/2013/09/04/record-price-new-car-august/2761341/
33 Real disposable personal income: per capita. http://research.stlouisfed.org/fred2/series/A229RX0
34 Marvel HP. The economics of information and retail gasoline price behavior: An empirical analysis. *J Polit Econ* 1976;84:1033–60.
35 Castanias R, Johnson H. Gas wars: retail gasoline price fluctuations. *Rev Econ Stat* 1993:171–4.
36 Grabowski DC, Morrisey MA. Gasoline prices and motor vehicle fatalities. *J Policy Anal Manag* 2004;23:575–93.
37 Chi G, McClure TE, Brown DB. Gasoline prices and traffic crashes in Alabama, 1999–2009. *Traffic Inj Prev* 2012;13:476–84.
38 Muller A. Evaluation of the costs and benefits of motorcycle helmet laws. *Am J Public Health* 1980;70:586–92.
39 Mayrose J. The effects of a mandatory motorcycle helmet law on helmet use and injury patterns among motorcyclist fatalities. *J Safety Res* 2008;39:429–32.
40 Governors Highway Safety Association. Motorcycle safety: a survey of state programs. http://www.ghsa.org/html/publications/pdf/survey/motorcycle/summary.pdf (accessed 10 Sep 2013).
41 Kraus JF, Peek C, McArthur DL, *et al*. The effect of the 1992 California motorcycle helmet use law on motorcycle crash fatalities and injuries. *JAMA* 1994;272:1506–11.
42 Walker I. Psychological factors affecting the safety of vulnerable road users: A review of the literature. http://staff.bath.ac.uk/pssiw/traffic/Walkerreview.pdf (accessed 10 Mar 2014).
43 DMV.ORG. Motorcycle License in California. http://www.dmv.org/ca-california/motorcycle-license.php (accessed 10 Feb 2014).
44 California Motorcyclist Safety Program. http://www.ca-msp.org/ (accessed 10 Feb 2014).

Power toolmakers oppose safety

There are an estimated 4000 blade saw amputations yearly in the USA. Technology can help prevent some of these injuries. SawStop makes a table saw blade stop when it hits flesh. But politics may get in the way of this protection. Some saw manufacturers seem uninterested in the device and oppose it being required. They assert that the injury numbers are inflated and the cost of the device would increase the price. *Comment*: Power tool manufacturers are another example of a self-regulating industry. (FairWarning) (Noted by IBP)

Special flooring reduces fall injuries in elderly

A study from Sweden shows that special impact-absorbing flooring reduced fall injuries in elderly women by nearly 60%. Interestingly, the soft floors may also be linked to more falls, but what matters most are the injuries. This is another example of technology, based on one of Haddon's principles, that actually works. In this study, the injury reduction was even greater than the authors expected. The report appears in the April 1 online issue of *Injury Prevention*. (Noted by IBP)

Vitamin D and exercises preventing fall injuries in the elderly

A new trial suggests that exercise and vitamin D supplements may be effective in reducing injuries in the elderly after falling. I 409 women 70–80 were randomly assigned to placebo, no exercise; supplemental vitamin D no exercise; placebo with exercise; and vitamin D with the excercise-supplement group were balance, weight bearing, strength and agility were 62% less likely to be injured compared with the placebo group, possibly attributable to increased bone density. (Noted by IBP)