MEDICAL CARE BLOG

The Association of Gasoline Prices With Hospital Utilization and Costs for Motorcycle and Nonmotorcycle Motor Vehicle Injuries in the United States

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Objectives: This study examined the association between gasoline prices and hospitalizations for motorcycle and nonmotorcycle motor vehicle crash (MVC) injuries.

Methods: Data on inpatient hospitalizations were obtained from the 2001 to 2010 Nationwide Inpatient Sample. Panel feasible generalized least squares models were used to estimate the effects of monthly inflation-adjusted gasoline prices on hospitalization rates for MVC injuries and to predict the impact of increasing gasoline taxes.

Results: On the basis of the available data, a \$1.00 increase in the gasoline tax was associated with an estimated 8348 fewer annual hospitalizations for nonmotorcycle MVC injuries, and reduced hospital costs by \$143 million. However, the increase in the gasoline tax was also associated with an estimated 3574 more annual hospitalizations for motorcycle crash injuries, and extended hospital costs by \$73 million.

Conclusions: This analysis of some existing data suggest that the increased utilization and costs of hospitalization from motorcycle crash injuries associated with an increase in the price of gasoline are likely to substantially offset reductions in nonmotorcycle MVC injuries. A policy decision to increase the gasoline tax could improve traffic safety if the increased tax is paired with public health interventions to improve motorcycle safety.

Key Words: traffic safety, gasoline price, fuel tax, motorcycle, hospitalization

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Motor vehicle crash (MVC) injuries are costly but preventable.[1] The Centers for Disease Control and Prevention reported that in 2012, MVC injuries were responsible for >1 million days of hospital stay and \$10 billion in inpatient care costs in the United States.[2] According to estimates from the National Highway Traffic Safety Administration, the number of MVC injuries has declined by 22% from 3,033,000 in 2001 to 2,362,000 in 2012.[3] However, the number of motorcycle MVC injuries significantly increased during the same time. In 2012, there were an estimated 93,000 motorcycle injuries in the United States—a 55% increase from 60,000 in 2001.[3]

Gasoline price has been linked to traffic safety. Previous studies have found that a rise in gasoline prices was associated with a decrease in the number and rate of MVCs and associated deaths.[4–17] A 10% increase in gasoline prices has been associated with up to a 2.3% decrease in the number of MVC fatalities per population,[5,6] and up to a 4.1% decrease in overall crashes per population.[10,11,13–15] Although increasing gasoline prices was associated with fewer MVCs, few studies have examined the impact of gasoline prices on motorcycling separately from other motor vehicles.[8,9,16] These studies suggest that gasoline prices were positively associated with motorcycle MVC injuries.[8,9,16] For example, 1 study predicted that a \$1 increase in gasoline price would result in over 1500 additional motorcycle fatalities in the United States.[9]

Gasoline prices have fluctuated substantially in recent years, increasing interest in their implications for traffic safety.[18,19] Gasoline price was as high as \$4 per gallon in 2008, compared with \$1.50 or lower in 2000, and with \$2.20 at the beginning of 2015.[20] Gasoline price is an important component in the cost of transportation, and may prompt people to reduce these costs by altering trip distance and frequency, transportation mode, and driving behaviors.[5,14,21–23] High gasoline prices have been shown to reduce vehicle miles traveled (VMT) and traffic congestion, thus reducing individuals' exposure to crash risk.[18,21,23] However, people may also respond to higher gas prices by substituting car driving with riding motorcycles and scooters.[9,16,19] Motorcycles are usually more fuel-efficient than automobiles or trucks, but they have a higher crash rate.[24,25] The number of registered motorcycles reached 8.5 million in 2012 compared with only 4.9 million in 2001.[3]

Prior research on the relationship of gasoline prices and MVC injuries is limited and has relied on crash reports provided by law enforcement.[4–17] These data provide little to no information on health services utilization or cost associated with MVCs. Our study contributes to this literature by using a nationally representative database of clinical records on injured motorcyclists and other motor vehicle drivers and passengers to determine the impact of gasoline prices on inpatient admissions and, ultimately, costs of treatment for motor vehicle injuries in the United States. To our knowledge, our study is also the first to estimate the impact of increasing gasoline taxes on motor vehicle inpatient admissions and costs of treatment in the United States.

METHODS

Data Sources

Data on inpatient hospitalizations for MVC injuries were obtained from the 2001 to 2010 Nationwide Inpatient Sample (NIS) datasets as part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality.[26] The NIS is the largest publicly available all-payer hospital inpatient database in the United States. The NIS was created by sampling 20% of all community, nonrehabilitation hospitals drawn from the HCUP State Inpatient Databases. In 2010, the NIS consisted of 7.8 million unweighted and 39 million weighted inpatient discharge records (1 record per visit).[26]

The NIS data elements include both clinical and nonclinical information for hospitalized patients, such as diagnoses, treatment procedures, disposition status, patient demographics, expected sources of payment, and total charges. Furthermore, the HCUP provides cost-to-charge ratios at the hospital or state peer-group level, which can be used to estimate the health care service cost or hospital received payment.[26,27] The NIS data can be used to estimate national and regional trends in hospital access and quality, especially for health service charges and costs.[26,28]

Gasoline price data were gathered by the Federal Highway Administration (FHWA), defined as the sum of retail gasoline price per gallon (excluding taxes) from the US Energy Information Administration (EIA) and federal and state taxes (excluding local and sales taxes) from the FHWA.[29] Although EIA provides the retail gasoline price data at the national and regional level, its definition of states in each region is not the same as the NIS's.[20,26] Therefore, FHWA data rather than EIA data were used in this study.

In addition, climate data (including precipitation and temperature) were derived from the National Climatic Data Center, US Department of Commerce; population data were derived from the US Bureau of the Census; unemployment rate data were derived from the US Bureau of Labor Statistics; and income per capita was derived from the US Bureau of Economic Analysis.[30–33] All above data were linked by region-month to generate an analysis dataset for this study.

Study Sample

This study focused on inpatient hospitalizations for MVC injuries, including drivers and passengers in motor vehicles other than motorcycles and riders and passengers on motorcycles. All MVC injuries were identified by motor vehicle traffic accident E codes (E810–E819), and the fourth digit of the E codes was used to define the crash victim type: nonmotorcycle motor vehicle driver (0) and passenger (1), and motorcycle rider (2) and passenger (3).[34] Fourth digits 4–9 were excluded from this study because the modes of transportation (such as horse, bike) do not use gasoline and it was unknown about how they were involved in the MVCs.

Because the NIS design allows producing only national and regional estimation, the observation unit was aggregated at the regional and monthly levels. Regions are defined as US census regions: Northeast, Midwest, South, and West.[26] The state of Florida (within the South region) was excluded from this study due to the unavailability of admission month data.[26] From 2001 to 2010, it was estimated that there were 1,653,641 and 313,005 inpatient hospitalizations for nonmotorcycle and motorcycle MVC injuries, respectively, in the United States (excluding Florida).

Measures

The weighted number of inpatient hospitalizations for MVC injuries refers to aggregated individual MVC inpatient cases for each month and each census region, and this number was stratified by injured victim type (nonmotorcycle motor vehicle and motorcycle). Correspondingly, the nonmotorcycle and motorcycle MVC injury hospitalization rates were calculated by dividing the aggregated numbers by annual regional population to generate hospitalizations per capita.

Monthly gasoline price was defined as the average regular gasoline price per gallon including tax for the states in each region. All prices were adjusted to 2010 dollars using the Consumer Price Index.[35] Gasoline tax (per gallon in 2010 dollars) included federal and state taxes.

The demographic characteristics of those who were hospitalized for MVC injuries include occupant type (driver/rider and passenger), sex (male and female), age (below 15, 15–20, 21–29, 30–44, 45–64, and 65 and more years), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other), and median household income for patient's ZIP code.[26] There were 4 quartiles for median household income, with a higher quartile representing higher median income. The principal injury diagnoses were categorized accorded to the Clinical Classifications Software.[36]

The total cost was estimated by multiplying total charges by the cost-to-charge ratios (CCRs) provided by HCUP.[27] Mixed CCRs were used in this study as recommended by HCUP, as follows: we used hospital-specific, all-payer inpatient CCRs first, and then used the group average all-payer inpatient CCRs if hospital-specific CCRs were not available. Records with missing total charges and CCRs were listwise deleted (11% of study sample). The mean of total cost was estimated by averaging total cost for all available cases. Length of stay was a count variable measured by number of inpatient days. If a patient was discharged on the same day as the admission, length of stay was coded as zero.

The covariates included monthly precipitation (inches), monthly temperature (°F), monthly unemployment rate (%),

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and annual inflation-adjusted income per capita ($000s) at the regional level. These variables were associated with the likelihood of a MVC used in previous studies.[5–17]

Statistical Analysis

We identified 4 regions from 2001 to 2010, with 480 region-month observations. We first described the number and rate of nonmotorcycle MVC and motorcycle hospitalizations over time, as well as trend in share of motorcycle in total MVC hospitalized injuries and inflation-adjusted gasoline prices. Second, patient characteristics were summarized and compared between 2 injured victim types. Third, panel feasible generalized least squares (PFGLS) models were used to examine the association among nonmotorcycle MVC hospitalization rate (per 10 million population), motorcycle crash hospitalization rate, and inflation-adjusted gasoline prices. We had long panel data with large T (120 mo) and small N (4 regions), and thus PFGLS was chosen because it was potentially more efficient on controlling serial correlation and other error process compared with other panel models for short panel data (eg, fixed-effects and random-effects models).[37] We calculated the predicted changes in the numbers of motorcycle and nonmotorcycle hospitalizations from increasing gasoline taxes by using estimates on the impact of gasoline taxes on hospitalization rates from the PFGLS model and the most recently available population estimates. Finally, we performed economic evaluation of the impact of gasoline taxation on aggregate MVC-related inpatient hospitalization costs, using PFGLS regression model estimates, population size, and hospitalization cost data from the NIS. All analyses took into account NIS survey design by using Stata 13.0 (Stata Corp, College Station, TX), and all results were weighted figures.[38]

Before performing the PFGLS regression, we first checked stationarity of the data by using the Levin-Lin-Chu unit-root test, and we also checked cointegration and serial correlation.[39] The test results showed that the month-region hospitalization rates for both nonmotorcycle and motorcycle MCV injuries were stationary with no cointegration. However, serial correlation existed. Therefore, a panel-specific first-order autoregressive process [an AR(1) process] was used. Finally, PFGLS models with heteroskedastic and correlated error structure were used to examine the coefficients.

RESULTS

Hospitalized Motorcycle and Nonmotorcycle Motor Vehicle Injuries

The price of gasoline (in 2010 dollars) exhibited a remarkable and consequent increase from $1.63 per gallon in 2002 to $3.20 in 2008 (Table 1). Over the same period, in the United States (excluding Florida), the number of hospitalizations for nonmotorcycle MVC injuries decreased from 168,296 in 2002 to 149,777 in 2008, and hospitalizations for motorcycle MVC injuries increased from 23,059 to 35,715 (Table 1). As illustrated in Figure 1, the annual correlation coefficient between inflation-adjusted gasoline prices and motorcycle-related MVC inpatient hospitalizations as a percentage out of all MVC inpatient hospitalizations was 0.88. When gasoline prices declined in 2009, the motorcycle MVC percentage showed a slight decrease after continuously rising for several years. In particular, there was a 60% increase in the percentage of motorcycle MVC hospitalized victims (9.8% in 2001 vs. 15.7% in 2010).

Demographic Characteristics of Crash Victims

Table 2 shows the demographic characteristics between motorcycle and nonmotorcycle MVC hospitalized victims. In general, drivers or riders, middle aged (30–64 y), male, and non-Hispanic whites accounted for more inpatient hospitalizations for MVC injuries; however, motorcycle MVC injuries seemed to be more concentrated in these groups. In terms of age, over 60% of those injured in motorcycle MVCs were between 30 and 64 years old. Younger (15–20 y old) and older (65+ years old) patients had higher proportions of nonmotorcycle MVC injuries than motorcycle MVC injuries. Nonmotorcycle MVC injuries were almost equally distributed in the 4 household income quartiles; however, patients residing in ZIP codes with higher median household income ZIP codes had a higher percentage of motorcycle MVC inpatient hospitalization. The characteristics of motorcycle and nonmotorcycle MVC victims who were hospitalized could be found in Table S1 (Supplemental material, Supplemental Digital Content 1, http://links.lww.com/MLR/B177), including principal injury diagnosis, primary payer, and disposition status.

Hospital Costs of Crash Victims

Mean hospital cost was $17,105 [95% confidence interval (CI), $16,458–$17,752] for nonmotorcycle MVC patients and $20,452 (95% CI, $19,630–$21,274) for motorcycle MVC patients—a difference of 20%. We also examined the average length of hospital stay in days and costs of inpatient treatment. The average length of stay was 5.5 days (95% CI, 5.2–5.9) and 6.2 days (95% CI, 6.0–6.4) for nonmotorcycle and motorcycle MVC patients, respectively. In addition, the hospital costs and average of length of stay for each type of principal injury diagnosis, primary payer, and disposition of patient are summarized in Table S2 (Supplemental material, Supplemental Digital Content 1, http://links.lww.com/MLR/B177).[36] For example, among nonmotorcycle MVC patients, private payers and self-pay accounted for a lower percentage of primary payers than among motorcycle MVC patients, whereas Medicare and Medicaid accounted for a higher proportion than that among motorcycle MVC patients.

Gasoline Prices and MVC Injuries

The results from the PFGLS models estimated that from 2001 to 2010, the coefficients of monthly inflation-adjusted gasoline price was -23.27 for nonmotorcycle motor vehicle hospitalization rates per 10 million population, and 9.96 for motorcycle hospitalization rate (Table 3). The PFGLS models predicted the impact of an increase in the gasoline tax. These results showed that a $1 increase in gasoline tax would be associated with 8348 fewer nonmotorcycle MVC victim hospitalizations representing $143

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TABLE 1. The Weighted Hospitalization Numbers and Rate Per 10 Million Population by Year and Vehicle Model, 2001–2010 Nationwide Inpatient Sample

	Gasoline Prices	Nonmotorcycle MV Inpatients			Motorcycle Inpatients		
Year	$	N	95% CI	Rate	N	95% CI	Rate
2001	1.73	164,572	136,973–192,171	6127	22,412	18,705–26,119	834
2002	1.63	168,296	138,892–197,699	6212	23,059	19,065–27,053	851
2003	1.79	194,321	158,131–230,510	7115	30,107	24,127–36,087	1102
2004	2.08	187,946	152,937–222,954	6825	32,303	26,066–38,540	1173
2005	2.46	171,782	141,608–201,957	6186	30,252	24,817–35,686	1089
2006	2.71	168,241	137,675–198,806	6004	33,015	26,758–39,272	1178
2007	2.86	144,805	116,882–172,727	5119	32,520	25,923–39,117	1150
2008	3.20	149,777	121,344–178,210	5245	35,715	28,378–43,052	1251
2009	2.32	141,570	115,936–167,204	4914	34,013	27,392–40,635	1181
2010	2.73	162,333	132,742–191,924	5588	39,608	31,811–47,406	1363
Total/mean*	1.73	1,653,641	1,516,264–1,791,019	5933	313,005	285,896–340,113	1117

Florida is excluded.
*The hospitalization numbers of nonmotorcycle motor vehicle and motorcycle are total values, and gasoline price and hospitalization rates are mean values.
CI indicates confidence interval; MV, motor vehicle.

million in hospital cost savings. However, increased hospitalizations from motorcycle injuries would substantially offset these savings. The $1 increase in gasoline tax was predicted to be associated with 3574 additional motorcycle MVC victim hospitalizations, accounting for >$73 million in hospital costs and offsetting half of the decrease in hospital costs from nonmotorcycle MVC (Fig. 2).

DISCUSSION

Historically, multiple public health strategies have been implemented to improve traffic safety in the United States, such as the seatbelt, the drunk driving and distracted driving laws, and some data indicate a decrease in the overall fatalities and injuries resulting from MVCs.[1–3] Gasoline taxation can be an important policy alternative to improve traffic safety, but, to our knowledge, the impact of increasing gasoline taxes on the motor vehicle injury admissions and costs of treatment in the United States has not been explored in prior studies.[4–17] This analysis was conducted to fill this gap. Our results suggest that the rising price of gasoline has a substantial effect on hospital utilization and costs for MVC injuries. The benefits of higher gasoline prices were associated with reduced hospitalizations and health care costs among nonmotorcycle MVC drivers and passengers from 2001 to 2010. However, these benefits were substantially offset by increasing hospitalization and costs from treating motorcycle MVC victims. In addition, inpatient care for those with motorcycle MVC injuries was more costly on average, thus increasing these individuals' financial burdens compared with those with nonmotorcycle MVC injuries. Compared with nonmotorcycle MVC victims, costs of treating motorcycle injury were more likely to be paid by private insurance and the victims themselves.

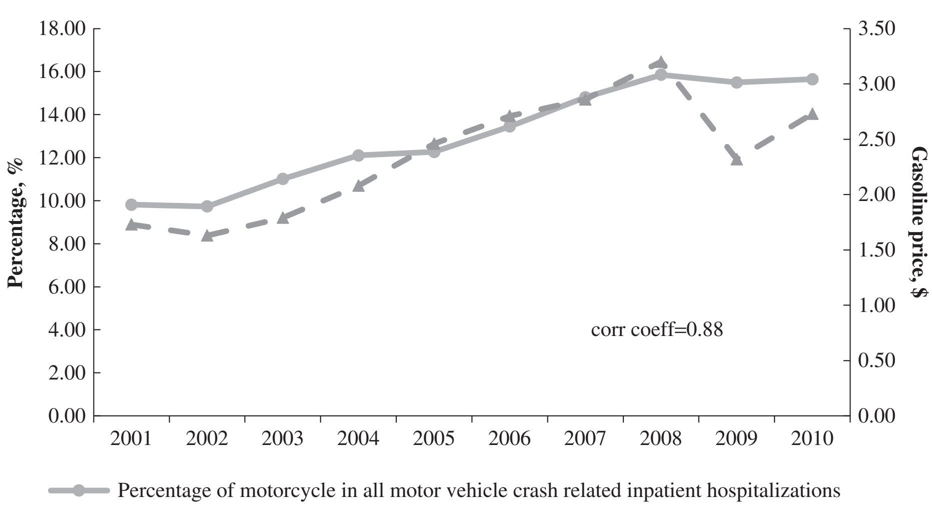

FIGURE 1. Inflation-adjusted gasoline prices and percentages of motorcycle-related inpatient hospitalizations out of all motor vehicle crash inpatient hospitalizations, 2001–2010 Nationwide Inpatient Sample. Florida is excluded. corr coeff indicates correlation coefficient.

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TABLE 2. Demographic Characteristics of Inpatient Crash Victims by Vehicle Mode, 2001–2010 Nationwide Inpatient Sample

	Nonmotorcycle MV Inpatients		Motorcycle Inpatients	
	N (%)	95% CI	N (%)	95% CI
Occupant type				
Driver/rider	1,146,900 (69.4)	68.8–69.9	291,755 (93.2)	92.9–93.5
Passenger	506,741 (30.6)	30.1–31.2	21,250 (6.8)	6.5–7.1
Age (y)				
< 15	81,458 (4.9)	4.4–5.5	6,514 (2.1)	1.9–2.3
15–20	246,764 (15.0)	14.7–15.3	23,392 (7.5)	7.2–7.8
21–29	315,908 (19.2)	18.8–19.5	62,229 (20.0)	19.4–20.6
30–44	359,211 (21.8)	21.4–22.2	101,383 (32.5)	32.0–33.1
45–64	371,429 (22.5)	22.2–22.8	107,084 (34.4)	33.6–35.1
65+	275,067 (16.7)	16.2–17.2	11,172 (3.6)	3.4–3.8
Sex				
Male	908,040 (55.2)	54.9–55.6	271,081 (87.5)	87.1–87.8
Female	736,662 (44.8)	44.4–45.1	38,846 (12.5)	12.2–12.9
Race/ethnicity				
White	856,739 (68.5)	66.3–70.7	193,295 (79.7)	77.8–81.5
Black	144,775 (11.6)	10.4–12.9	19,759 (8.2)	7.2–9.2
Hispanic	162,752 (13.0)	11.3–14.9	18,874 (7.8)	6.6–9.2
Other	86,056 (6.9)	6.2–7.7	10,510 (4.3)	3.7–5.0
Median household income for patient's zip code				
1st quartile	387,999 (24.2)	22.5–26.0	60,211 (19.8)	18.3–21.4
2nd quartile	411,304 (25.7)	24.6–26.7	74,765 (24.6)	23.5–25.7
3rd quartile	393,405 (24.5)	23.6–25.5	82,708 (27.2)	26.2–28.2
4th quartile	410,918 (25.6)	23.6–27.8	86,408 (28.4)	26.4–30.5

Florida is excluded.
CI indicates confidence interval; MV, motor vehicle.

In the context of high gasoline prices, the decline in MVC injuries may be related to a reduction of VMT and an increase in public transportation ridership. VMT per vehicle decreased 9% over the study period, from 12,600 miles annually in 2001 to 11,500 miles in 2010.[3] The Congressional Budget Office reported that a 10% increase in gasoline price would reduce VMT by 1.1% to 1.5%.[21] In addition, previous studies have suggested that people may drive slower in response to high gasoline prices, increasing driving safety, and that gasoline prices may have a disproportionate effect in reducing nonmotorcycle MVC injuries among young adults.[5] Furthermore, the use of public transportation (such as buses and subways) may also reduce the probability of injuries. One study found that increasing gasoline prices were significantly associated with increased public transit ridership in nine major United States cities, especially in more car-dependent cities.[40] The American Public Transportation Association estimated an additional 670 million public transportation passenger trips per year when regular gasoline price reached $4 per gallon.[23]

The gasoline tax is an important policy tool for increasing government revenues and controlling negative externalities such as vehicle emissions.[4,41–43] Gasoline taxes could also be an alternative policy to improve traffic safety, as it is associated with reductions of MVC fatalities and injuries in this study and in the literature.[4–17] The United States has almost the lowest gasoline tax among industrialized countries, while it has the highest fatality and injury rate per capita.[44,45] The federal tax has been $0.184 per gallon since 1993, and the weighted average of state taxes is around $0.20 per gallon.[29] These taxes accounted on average for 19% of retail gasoline prices from 2001 to 2013, and this percentage has been decreasing due to stable taxes and rising gasoline prices.[20] However, other countries charge >10 times this amount. For example, in 2010 the gasoline tax rate was $4.58 per gallon in the United Kingdom, $4.50 in Germany, and $2.83 in Japan.[29] One recent proposal to increase the federal gasoline tax failed in Congress, and some states have even decreased gasoline taxes.[29,46] The International Monetary Fund has suggested that the United States should have a $1.40 gasoline tax per gallon to lessen the environmental impact of burning gasoline, although, opponents argue that higher gasoline taxes would hurt low income families.[47,48] However, there has been little discussion of the potential negative impact of gasoline taxes on traffic safety resulting from substitution toward motorcycling in response to higher retail gasoline prices.

Our finding that the tax would increase motorcycle MVC injuries is consistent with previous studies of time periods when gasoline prices were high. Prior studies using data from 1976 to 2012 found that motorcyclist fatalities, motorcycle registrations, and gasoline prices were positively associated.[8,9,16,19] Substituting motorcycling for driving a car in response to rising gasoline prices may result from a number of factors including individuals' motivations to ride a motorcycle (eg, riding for leisure or commuting), riders' skill and experience, and driving environment. Interestingly, although having low income may also be a factor in increasing the likelihood of this substitution, our data suggest that patients residing in ZIP codes with higher median household income ZIP codes have a higher percentage of motorcycle MVC inpatient hospitalizations. Although further research is warranted to characterize this substitution, the substitution of motorcycling for driving is expected to

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TABLE 3. Estimations of Panel Feasible Generalized Linear Square Models for Nonmotorcycle Motor Vehicle and Motorcycle Hospitalization Rates Per 10 Million Population, 2001–2010 Nationwide Inpatient Sample

	Coefficients of Predictors					
	Monthly Nonmotorcycle Motor Vehicle Inpatient Hospitalization Rate[*]			Monthly Motorcycle-related Inpatient Hospitalization Rate[†]		
Outcomes	**Model 1**	**Model 2[‡]**	**Model 3**	**Model 4[‡]**	**Model 5**	**Model 6**
Monthly inflation-adjusted gasoline price ($ per gallon)	−43.63 (11.88)[§]	−23.27 (9.03)[∥]	−21.90 (9.21)[∥]	9.96 (2.92)[¶]	9.54 (3.55)[¶]	10.16 (3.90)[¶]
Monthly precipitation (inch)	0.32 (1.62)	−1.00 (1.36)	−1.94 (1.29)	−3.66 (0.53)[§]	−3.21 (0.54)[§]	−3.10 (0.55)[§]
Monthly temperature (°F)	1.10 (0.30)[§]	0.34 (0.50)	−0.53 (0.50)	1.94 (0.20)[§]	2.10 (0.22)[§]	2.18 (0.22)[§]
Monthly unemployment rate (%)	−1.86 (5.58)	−4.25 (7.43)	−8.03 (7.87)	3.91 (1.25)[¶]	4.26 (1.12)[¶]	4.94 (3.01)
Annual inflation-adjusted income per capita ($1000)	4.92 (1.91)[∥]	6.72 (1.86)[§]	−26.23 (16.69)	2.39 (0.49)[§]	1.93 (1.81)	0.78 (3.93)
Region-fixed effects	No	No	Yes	No	Yes	Yes
Month-fixed effects	No	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	No	Yes	Yes	No	No	Yes
Panel-specific AR(1)	Yes	Yes	Yes	Yes	Yes	Yes

Florida is excluded. SEs are presented in parentheses.
*Model 1–3 were used to estimate the effect of gasoline price on nonmotorcycle motor vehicle inpatient hospitalization rate by controlling different region, year, month, and panel-specific AR (1).
†Model 4–6 were used to estimate the effect of gasoline price on motorcycle inpatient hospitalization rate.
‡The coefficients of Model 2 and Model 4 were used to estimate the effects because of the smallest SEs.
§Statistically significant at 1% level.
∥Statistically significant at 10% level.
¶Statistically significant at 5% level.

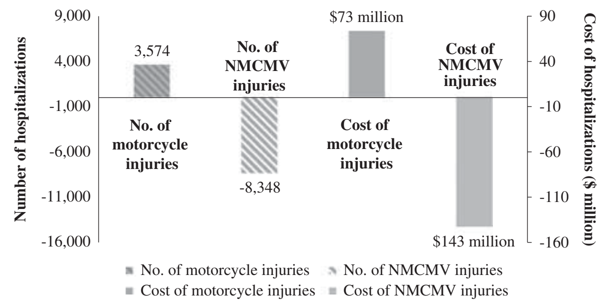

FIGURE 2. Predicted impact of increasing gasoline tax by $1.00 on hospitalizations and associated cost for motorcycle and nonmotorcycle motor vehicle injuries. Florida is excluded. NMCMV indicates nonmotorcycle motor vehicle.

increase crashes because of the substantially higher risk of injury from riding compared with driving.[24] Thus, increased attention should be paid to motorcycle safety, especially during periods of increasing gasoline prices. Helmet laws and more training for motorcyclists will help to improve motorcycle safety. Although helmet use has been proven to effectively reduce injury severity, particularly for traumatic brain injuries, only 19 states and the District of Columbia have universal helmet laws, 28 states have helmet laws for teens, and 3 states (Illinois, Iowa, and New Hampshire) have no helmet law at all.[49,50]

This study has several limitations. First, the state of Florida was excluded from the sample because of missing admission month information. Despite this exclusion, the annual rate of motorcycle and nonmotorcycle MVCs in Florida was checked and was found to share substantively similar trends with other states in the South region, which may help mitigate the effect of the missing data. Second, the regional gasoline price was the unweighted average price across states within each region, but the unweighted prices were almost identical to the weighted prices at the annual level. Third, we could not control for state-level policies (such as helmet laws), because our data were at the region level. Lastly, data on individual motivations to ride a motorcycle (eg, riding for leisure or commuting), riders' skill and experience, motorcycle model (eg, engine size), and driving environment were not available. These factors are not included in the analysis, and it is not possible to determine the extent to which rising gasoline prices result in changing patterns of commuting or noncommuting trips and relative crash risk.

This study explored the relationship between gasoline prices and motorcycle and nonmotorcycle-related hospitalized injuries, and using the available data to estimate the impact of increasing the cost of gasoline on inpatient treatment costs. An increase in the retail price of gasoline was associated with increases in the number of injuries and treatment costs from motorcycle crashes, which substantially offset any reduction in nonmotorcycle MVC injuries. These findings suggest that the gasoline tax could be a policy strategy to improve traffic safety, provided that it is paired with efforts to improve motorcycle safety.

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