AMERICAN JOURNAL OF
Preventive Medicine

RESEARCH ARTICLE

Primary Enforcement of Mandatory Seat Belt Laws and Motor Vehicle Crash Deaths

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Introduction: Policies that allow directly citing motorists for seat belt non-use (primary enforcement) have been shown to reduce motor vehicle crash deaths relative to secondary enforcement, but the evidence base is dated and does not account for recent improvements in vehicle designs and road safety. The purpose of this study was to test whether recent upgrades to primary enforcement still reduce motor vehicle crash deaths.

Methods: In 2016, researchers used motor vehicle crash death data from the Fatal Analysis Reporting System for 2000–2014 and calculated rates using both person- and exposure-based denominators. Researchers used a difference-in-differences design to estimate the effect of primary enforcement on death rates, and estimated negative binomial regression models, controlling for age, substance use involvement, fixed state characteristics, secular trends, state median household income, and other state-level traffic safety policies.

Results: Models adjusted only for crash characteristics and state-level covariates models showed a protective effect of primary enforcement (rate ratio, 0.88, 95% CI=0.77, 0.98; rate difference, –1.47 deaths per 100,000 population, 95% CI= –2.75, –0.19). After adjustment for fixed state characteristics and secular trends, there was no evidence of an effect of upgrading from secondary to primary enforcement in the whole population (rate ratio, 0.98, 95% CI=0.92, 1.04; rate difference, –0.22, 95% CI= –0.90, 0.46) or for any age group.

Conclusions: Upgrading to primary enforcement no longer appears protective for motor vehicle crash death rates.
Am J Prev Med 2017;▮(4):▮▮▮–▮▮▮.

INTRODUCTION

The U.S. has made great strides in reducing deaths from motor vehicle crashes (MVCs), even as the number of vehicle miles traveled (VMT) has increased.[1,2] These reductions have come from improved road design, changes in vehicle safety and driver behavior, and safety legislation.[3,4] Despite this success, MVCs continue to result in some 30,000 deaths annually in the U.S., so it is important to understand what works to design effective policies and optimize prevention strategies.

Seat belt use dramatically reduces the likelihood of death in a crash,[5] and increases in seat belt use since the mid-1980s have made an important contribution to reductions in MVC death rates. A number of prior studies have found that mandatory seat belt laws have been effective in increasing seat belt use and reducing crash-related deaths, and that laws with primary enforcement are more effective than laws with secondary enforcement.[6–10] Primary enforcement means that drivers may be directly cited for seat belt non-use, whereas secondary enforcement means that non-belted drivers may be additionally cited after another traffic infraction. Because of the direct penalty imposed by primary enforcement, there is some reason to hypothesize that

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0749-3797/$36.00
http://dx.doi.org/10.1016/j.amepre.2017.02.003

primary laws may be more effective than secondary laws in reducing MVC deaths.[11,12]

Although the past literature on mandatory seat belt laws suggests they reduce MVC death rates, much of the literature is based on studies from the 1980s and 1990s when rates of seat belt use were considerably lower than they are today. National seat belt use (among drivers and front seat passengers) has plateaued near 90%,[13] but MVC death rates are still declining (Figure 1), so other environmental factors (e.g., road design, vehicle safety features) may now be playing a more prominent role. Recent studies of changes in vehicle design also suggest strong impacts on MVC death rates,[14,15] so it is not clear whether states presently considering upgrading their existing seat belt laws to primary enforcement can expect the benefits seen in prior studies. Sixteen states upgraded their mandatory seat belt laws from secondary to primary enforcement since 2000, which provides an opportunity to test whether such policy changes continue to affect MVC death rates.

METHODS

Data Sample

In 2016, the researchers obtained person-level data on fatal crashes from the Fatal Analysis Reporting System (FARS)[16] for 2000–2014. The data set was restricted to fatalities among individuals who were drivers or passengers in motor vehicles. Data on mandatory seat belt policies, including the date and type of enforcement (secondary or primary) were abstracted from the Insurance Institute for Highway Safety.[17] New Hampshire, which is the only state without a mandatory seat belt law covering adults, was excluded. Person-level crash data were aggregated by state; age group (<10, 10–14, 15–19, 20–24, 25–34, 35–44, 45–54, 55–64, 65–74, and ≥75 years); and year of crash, so that each observation contains MVC deaths by age group, state, and year. The exact date when each law became effective[17] was used to calculate the proportion of months in a given year a state had a primary law in effect. For example, Arkansas upgraded from secondary to primary enforcement on June 30, 2009, and was coded as 0.5 for 2009 and 1 thereafter. Appendix Table 1 (available online) provides the effective dates of mandatory law adoption (Appendix Figure 1 [available online] provides a map) and overall MVC death rates for each state.

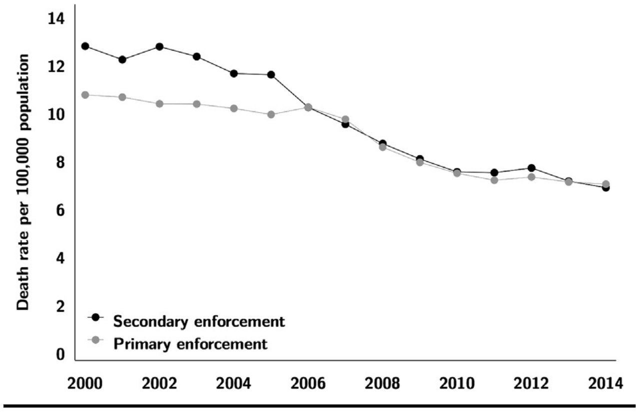

Figure 1. Motor vehicle crash death rates per billion vehicle miles traveled in U.S. states, by mandatory seatbelt status, 2000–2014.
Source: Authors' calculations.
Note: New Hampshire omitted.

Two sets of denominators were used to estimate MVC death rates, by population and by travel exposure (i.e., VMT). Annual population estimates by age group, state, and year were obtained from the U.S. Census Bureau.[18] Annual estimates of state-specific VMT were calculated from the FARS website,[19] which provides the number of fatalities and the fatality rate per 100 million VMT annually for each state. Estimates of VMT were not available by age at the state level.

Because other aspects of safety legislation also changed over this period and could be associated with changes in seat belt laws and MVC death rates, the research team also obtained time-varying data on laws pertaining to maximum speed limits, legal limits for blood alcohol concentration, and graduated driver's license programs,[17] and, additionally, police per capita as a proxy for enforcement,[20] average alcohol consumption,[21] and state median household income (constant dollars) from the U.S. Census.[22] Adjustments were also made for the proportion of fatal crashes on rural roads and the proportion of fatal crashes involving alcohol (based on reported blood alcohol concentration and police-reported alcohol involvement).

Statistical Analysis

Because states that do not change their enforcement status over the study period serve as controls for those that do, the researchers assessed balance in demographic and policy covariates across enforcement status by calculating standardized differences across states according to whether a given state remained secondary, primary, or upgraded from secondary to primary enforcement. A standardized difference is the difference in covariate means between two groups divided by their average SD,[23] which allows comparison of balance across covariates measured on different scales (e.g., VMT versus speed limit laws). Values >10% are typically considered indicative of a risk for bias.[24]

The theoretic effect of interest is the difference between the MVC death rate among states that upgraded to primary enforcement and the MVC death rate among those same states had they not upgraded. Unadjusted negative binomial regression models were used to model the association between primary enforcement upgrades on MVC death rates, using either the age–state–year–specific population or state–year–specific VMT as the offset. Coefficients from these models were used to generate marginal predicted MVC death rate differences and rate ratios. Negative binomial regression assumes that MVC deaths follow a Poisson process, but relaxes the assumption that the mean and variance are equal.[25] Covariate-adjusted models were then estimated with controls for age group (as indicator variables), the proportion of deaths involving alcohol or occurring on rural roads, and state-level confounders, followed by a third model that also included indicator variables for each state and for each year of observation. State indicators control for any fixed unobserved differences across states (e.g., driving norms, general weather conditions) that may also be correlated with MVC death rates. Indicator variables for