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Effects of safety belt laws on safety belt use by American High School Seniors, 1986–2000

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Abstract

Problem: This manuscript evaluates the effects of enactment of state laws that required safety belt use in various U.S. states between 1986 and 2000. *Method*: Safety belt use was assessed using nationally representative cross-sectional samples of high school seniors; evaluation of the effects of laws used data from over 2,000 high school seniors before and about 3,300 after the laws took effect in 20 states. *Results*: Belt use was found to increase significantly between 1986 and 2000, and the laws contributed significantly to that increase. Increases were similar for students differing by gender, race/ethnicity, parent education, grades, truancy, evenings out per week, miles driven per week, and an index of illicit drug use. *Discussion*: The data show that although the laws have increased belt use, use is not universal and continued efforts are needed. *Impact on Research, Practice, and Policy*: This study shows that many teenagers fail to use belts when there is a secondary use law; an implication is that primary laws would be more efficacious in increasing use among this vulnerable population.

Keywords: Policy evaluation; Safety belt laws; Safety belt use; Youth

1. Introduction

The purpose of this study is to provide additional information about the effects of policies designed to reduce deaths and injuries from vehicle crashes—laws that requires the use of safety belts. The focus is on safety belt use among a particularly important age group at high risk of crash involvement – adolescents. Other research has found that safety belt use in the United States has increased substantially since the mid-1980s in the general population (Nelson, Bolen, & Kresnow, 1998), but the degree to which adolescents are responsive to such laws is not known. Research has also found that belt laws resulted in significant overall reductions in car crash fatalities (Wagenaar, Maybee, & Sullivan, 1988) and injuries (Wagenaar & Margolis, 1990). The data analyzed in the present study provide an opportunity to assess potential differential effects of the laws on subgroups of adolescents who differ on sociodemographic characteristics, as well as on risk-taking behaviors. The study uses data from a large-scale on-going series of surveys to investigate the question as to whether there is any evidence that enactment of a secondary-enforcement safety belt law affects safety belt use behavior by young drivers and passengers and, if so, whether the effects vary by individual characteristics.

2. Methods

Outcome data are from a large-scale series of annual surveys of high school seniors across the United States, entitled the "Monitoring the Future" (MTF) project, which is conducted by the Institute for Social Research at the University of Michigan. The major analyses examined the effect of safety belt law changes in a total of 20 states that changed their laws between 1986 and 2000. States included in the study and the effective dates are provided in Table 1; in all cases, the laws are secondary-enforcement laws. Some states subsequently changed the enforcement from secondary to primary, but there were too few cases available for analysis of this change.

The MTF surveys involve nationally representative surveys of each U.S. high school senior class, beginning in

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Table 1
Secondary safety belt law enactment for 20 states with before and after data available

State	Date 1st safety belt law enacted	Legal citation	Current citation
Alabama	07/18/1991	1991 Ala. Acts 255	(note (1))
Arkansas	07/15/1991	1991 Ark. Acts 562, § 4	Ark. Code Ann. § 27-37-704 (West, 2002)
Arizona	12/31/1990	1990 Ariz. Sess. Laws 240, § 3	Ariz. Rev. Stat. Ann § 28-909 (West, 2002)
Colorado	07/01/1987	1987 Colo. Sess. Laws 318, §1	Colo. Rev. Stat. Ann. § 42-4-237(5) (West, 2002)
Florida	07/01/1986	1986 Fla. Laws 86-49, § 2	Fla. Stat. Ann. § 316.614(8) (West, 2002)
Georgia	09/01/1988	1988 Ga. Laws 819, §1	(note (2))
Indiana	07/01/1987	1985 Ind. Acts 122, §1	(note (3))
Kentucky	07/15/1994	1994 Ky. Acts 39, § 1	Ky. Rev. Stat. Ann § 189.125 (West, 2002)
Louisiana	07/01/1986	1985 La. Acts 377, § 1	(note (4))
Massachusetts	02/01/1994	1993 Mass. Acts 387, § 1	Mass. Gen. Laws Ann. ch. 90, § 13A (West, 2002)
Maine	12/27/1995	1995 Me. Laws 432, § 3	Me. Rev. Stat. Ann. tit. 29-A, § 2081(4)(E) (West, 2002)
Minnesota	08/01/1986	1986 Minn. Laws 310, § 3	Minn. Stat. Ann. § 169.686, subd. 1 (West, 2002)
Ohio	05/06/1986	1986 Ohio Laws S. 54, §1	Ohio Rev. Code Ann. § 4513.263 (D) (West, 2002)
Pennsylvania	11/23/1987	1987 Pa. Laws 399, § 5	Pa. Stat. Ann. tit. 75, § 4581 (a)(2) & (b) (West, 2002)
Tennessee	04/21/1986	1986 Tenn. Pub. Acts 866, §§ 3,4,7,8,11	Tenn. Code Ann. § 55-9-603 (West, 2002)
Virginia	01/01/1988	1987 Va. Acts ch. 538	Va. Code Ann. § 46.2-1094(F) (West, 2002)
Washington	06/11/1986	1986 Wash. Laws 152, § 1	(note (5))
Wisconsin	12/01/1987	1987 Wis. Laws 132, §§ 3 to 6	Wis. Stat. Ann. § 347.48(2m)(gm) (West, 2002)
West Virginia	06/16/1993	1993 W. Va. Acts 100	W. Va. Code § 17C-15-49 (West, 2002)
Wyoming	06/08/1989	1989 Wyo. Sess. Laws 274, § 1	Wyo. Stat. Ann. § 31-5-1402(d) (West, 2002)

1975. The larger MTF survey design and results have been described in detail elsewhere (Bachman, Johnston, & O'Malley, 2001; Johnston, O'Malley, & Bachman, 2002). We summarize here measures used for the present analyses, and describe sampling and statistical analysis considerations.

2.1. Measures

Two items measured the core outcome of interest for the current study: "*When you drive a car, how often do you wear a seatbelt*?" and "*When you are riding in the front passenger seat of a car, how often do you wear a seatbelt?*" Response alternatives were (1) Never, (2) Seldom, (3) Sometimes, (4) Often, and (5) Always; an additional category "Does not apply" was also available. The questions used the term "seatbelt;" however, because the generally accepted term today is "safety belt," this terminology is used here. Additional items measured drinking and driving behaviors: "*During the last two weeks, how many times (if any) have you driven a car, truck, or motorcycle after drinking alcohol?*" and a parallel item assessed riding with a drinking driver: "*During the last two weeks, how many times (if any) have you been a passenger in a car when the driver had been drinking?*" Questionnaire response alternatives are: None (0), Once (1), Twice (2), 3–5 times (3), 6–9 times (4), and 10 or more (5).

2.2. Sampling design and analyses

A three-stage national probability sample results in self-completed questionnaire administrations in about 135 high schools across the United States (approximately 112 public and 23 private) and yields about 17,000 respondents per year. The response rate is about 83% of all seniors, with absentees accounting for nearly all of the non-respondents. Schools are requested to participate for two consecutive years; thus, each year half of the schools are participating for the first time and half are participating for the second time. When a sampled school is unwilling to participate, a replacement school is selected, controlling for factors such

Notes to Table 1
(1) AL: Secondary law was formerly contained in Ala. Code § 32-5B-5. In 1999 Ala. Acts 397, eff. 12/10/99, enforcement level changed from secondary to primary.
(2) GA: GA secondary law took effect on 9/1/1988. As of 7/1/1996, it was changed to primary enforcement by 1996 Ga. Laws 748. Current citation is: Ga. Code Ann. § 40-8-76.1 (West, 2002).
(3) IN: IN secondary law was enacted by 1985 Ind. Acts 122 and took effect on 7/1/1987. Recodified by 1991 Ind. Acts 2. As of 7/1/1998, it was changed to primary law by 1998 Ind. Acts 116, § 2. Current citation is: Ind. Code § 9-19-10-3 (West, 2002).
(4) LA: As of 11/1/1995 (1995 La. Acts 643, § 1), La. Moved from secondary to primary enforcement: current citation is La. Rev. Stat. Ann. § 32:295.1 (West, 2002).
(5) WA: As of 7/1/2002 (2002 Wash. Laws 328, § 2) WA moved from secondary to primary enforcement: Wash. Rev. Code Ann. § 46.61.688(7) (West, 2002).

as population density, geographic region, size, racial composition, and other relevant factors.

MTF sampling procedures do not result in a rigorously representative sample within each state in the study. The samples are drawn so as to be nationally representative, including all geographic regions, levels of population density, types of schools, and so on; more precisely, the design is such that the samples are representative of each of the four major geographic regions (Northeast, North Central, West, and South). While it is not the case that the sample in any single state is statistically representative of that state, it is the case that as one aggregates across states, one approaches a representative sample for the aggregate set of states. Thus, for example, data aggregated across the 20 states with a changed safety belt law should fairly accurately represent all seniors who live in states with a changed safety belt law. In the aggregate, this should be a more-than-adequate sample from which to draw inferences about the effects of safety belt law changes. The available data do not, however, permit accurate assessment of potential differential effectiveness of the legal changes across individual states.

Although the MTF study has been conducted annually since 1975, questions on safety belt use were added in 1986; thus, analyses reported here are based on 1986 through 2000 data. The questions on safety belt use are included in only one of six questionnaire forms (distributed in a random sequence within classroom); thus, analyses are based on a random one-sixth of the total survey sample. Baseline, or "before," data for analyses reported here consist of students surveyed within three years before the safety belt law took effect in their specific state of residence, and post-law or "after" data consist of students surveyed within three years after the safety belt law took effect in their state. In short, we used samples of high school students before and after safety belt laws were enacted within each state experiencing such a policy change from 1986 to 2000, then aggregated the state-specific samples to obtain a single overall best estimate of the effects of such policies on self-reported safety belt use. Sample sizes are approximately 2,300 respondents in 124 schools surveyed before the law change and 3,300 respondents in 169 schools surveyed after the law change (the respondent numbers vary slightly by variable due to missing data on select items). Thus, we used a pre-post design with repeated but separate cross-sectional probability samples of high school seniors (not a cohort design).

The sampling design is clustered, where students are not directly selected at random from the population of all students, but rather schools serve as the primary sampling unit, and students are nested within schools. As a result, standard errors are larger than those that would result from a simple random sample of the same size (Kish, 1965). Thus, it would be inappropriate to apply the standard, simple random sampling formulas to assess statistical significance. However, the effect of the sampling design can be estimated, obtaining a measure called a "design effect." The design effect is then used to adjust the actual number of cases, by simply dividing the number by the value of the design effect, thereby "depreciating" the number to an appropriate value in simple random sample terms. Design effects were estimated using software written by Raghunathan, Solenberger, and Van Hoewyk (2000), and all significance tests reported here have been adjusted to account for this design effect. The design effect is estimated to be approximately 3.0 for analyses of the change effect; this is likely to be an over-estimate, but as shown below, effects are still statistically significant (using a .01 level of significance) and would only be more significant with a lower design effect estimate. Analyses are based on the general linear model, using SAS PROC GLM (SAS Institute, 2000). We also controlled for broad national ("secular") trends in each outcome examined, to ensure that estimated policy effects are not attributable to behavioral changes due to other factors occurring both in states that changed their safety belt laws and in states that did not.

In summary, we examined the effect of safety belt law changes in those states that changed their law during the study period for which we had "before" and "after" data. It was necessary to combine data across states because the numbers of schools and students in individual states did not provide sufficiently large samples to allow accurate estimates for individual states. We compared rates of safety belt use in the same states for one to three years before and after the law changes. We used as much data as was available, but if a change occurred in, for example, 1987, there could be only one year of "before" data. In addition to the straightforward before/after analyses, we also incorporated adjustments for secular trends and for the clustered sample design. Adjustments for secular trends involved subtracting each individual's score from the overall mean, across all students, for that year. The estimated design effect was used to adjust for the clustered sample design in assessing statistical significance; a significance level of .01 was used for all tests.

3. Results

3.1. Evaluation of effect of state laws

Table 1 indicates the various states and the dates when the safety belt laws were changed. (Only states for which there were some before and after data available are shown.) Existing lists of safety belt laws, and their effective dates, sometimes contain discrepancies with one another. For this study, all laws and their effective dates were independently verified; LaFond, Toomey, Rothstein, Manning, and Wagenaar (2000) have demonstrated the need for such verification, based on their finding of considerable measurement errors in published policy data.

Table 2 shows the means for selected variables, based on up to three years of data, both before and after the laws went into effect. Results show clearly that the changed safety belt

Table 2
Comparison of mean safety belt use by high school seniors, before and after law changes in 20 states, 1986–2000

Means of frequency of use	Number of students		Mean		Standard Deviation		Effect Size[1]
	Before	After	Before	After	Before	After	
Wear seat belt as driver	2271	3235	2.846	3.581	1.553	1.507	.473**
Wear seat belt as passenger	2300	3303	2.777	3.523	1.506	1.479	.495**
Drive after drinking alcohol	2318	3322	1.468	1.394	0.987	0.898	− .075 ns
Ride with drinking driver	2314	3325	1.670	1.588	1.126	1.046	− .073 ns
Means adjusted for secular trends							
Wear seat belt as driver	2271	3235	− 0.432	0.129	1.525	1.511	.368 **
Wear seat belt as passenger	2300	3303	− 0.429	0.125	1.472	1.481	.376 **
Drive after drinking alcohol	2318	3322	0.019	− 0.014	0.983	0.895	− .034 ns
Ride with drinking driver	2314	3325	0.022	− 0.024	1.121	1.043	− .041 ns

Proportions who always wear	Number of Students		Proportion		Standard Deviation		Effect Size[2]
Wear seat belt	Before	After	Before	After	Before	After	
Wear seat belt as driver	2271	3235	0.243	0.433	0.429	0.495	.190**
Wear seat belt as passenger	2300	3303	0.205	0.393	0.404	0.488	.188**
Proportions adjusted for secular trend							
Wear seat belt as driver	2271	3235	− 0.118	0.026	0.427	0.495	.144**
Wear seat belt as passenger	2300	3303	− 0.116	0.025	0.402	0.488	.141**

ns = not significant.
** $p < .01$.
[1] Expressed as difference divided by "before" standard deviation.
[2] Expressed as difference in proportions, "After" minus "Before."

laws were followed by statistically significant increases in the amount of safety belt use by high school seniors. The mean frequency of safety belt use as a driver on the 5-point scale described earlier went from 2.846 before the law to 3.581 following implementation of the new laws ($p < .01$); this increase is 47.3% of the baseline standard deviation. The mean frequency of safety belt use as a passenger went from 2.777 before the law to 3.523 following implementation of

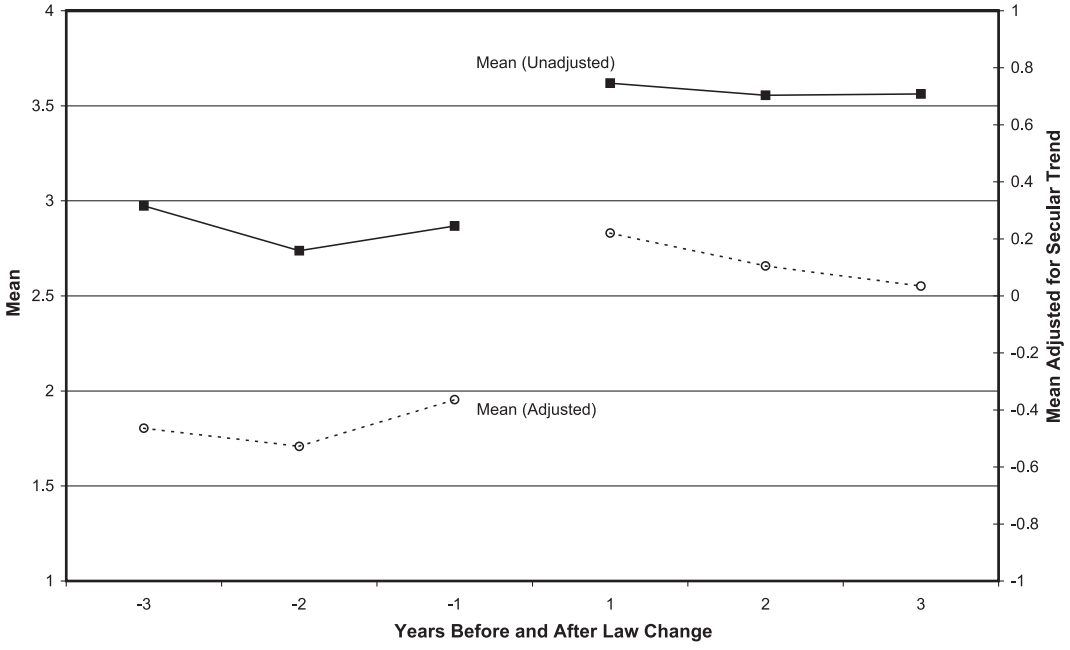

Fig. 1. Safety belt use by high school seniors in 20 states, before and after law change.

the new laws ($p < .01$), a change of 49.5% of the baseline standard deviation.

Because there was a general secular trend of increasing safety belt use during the interval from 1986 to 2000, these changes could conceivably reflect only the overall increase. Thus, means adjusted for secular trends are also shown in Table 2. These are simply the difference between each student's reported use and the overall average use based on all students for that year. These show clearly that the changes remain significant after controlling for overall secular trend: there is still about 37% of a standard deviation increase in safety belt use.

Fig. 1 provides a graphic display of the mean use in each of the three years before and after the law change in the 20 affected states. The sharp increase in the year immediately after the law was enacted, coupled with the general lack of systematic trend either before or after the enactment suggests strongly that the law change is likely to be the principal cause of the change in behavior.

It could be argued that the observed increases in safety belt use reflect a growing cautiousness about risky behaviors among high school seniors and that safety belt laws have little to do with the changes. Table 2 also shows means for two other driving-related behaviors that one would not expect to be affected by safety belt laws: driving after drinking, or riding with a driver who had been drinking. These show no significant changes before and after the safety belt law changes. Thus, the behavioral changes appear specific to the targeted behavior.

Table 2 also provides the proportion of seniors who say that they "always" use a safety belt when driving or when riding as a passenger in the front seat, before and after the law change. The changes in proportions using belts is very substantial, with 43.3% reporting always wearing a safety belt when driving after the law went into effect, compared to 24.3% before the law.

One question that may be raised is whether these changes are restricted to certain types of individuals, or if they occur broadly across a range of types of individuals. Table 3 provides information that addresses this question. Individuals are categorized into dichotomies based on gender, race/ethnicity, parent education, grade point average, truancy, number of evenings out per week, miles driven per week, and an index of illicit drug use; changes in frequency of safety belt use when driving are shown for each of these categories. As can be seen in the column labeled "Effect size," the changes seen after the law change are generally similar across the two subgroups for each variable. For example, there was an increase of 49.1% of a standard deviation in safety belt use among those whose grade point average was B or lower, compared to a corresponding increase of 45.4% among those whose grade point average was B+ or higher. The one major apparent exception to the similar rates of change is for the race/ethnicity dichotomy, where minority students increased belt use considerably more as a percentage of a standard deviation than did white students. However, this is primarily due to the lower standard deviation of this group in the "before" condition and, even here, the interaction is not statistically significant. All other interactions were also not statistically significant. Thus, the changes related to the new laws observed in Table 2 appear to reflect changes that occurred among students of all types.

Table 3
Mean safety belt use when driving, before and after safety belt law change, by subgroups of high school seniors, 1986–2000

	Number		Mean of Frequency		Standard Deviation		Effect size
	Before	After	Before	After	Before	After	
Gender							
Male	1095	1502	2.626	3.370	1.528	1.549	.487
Female	1131	1679	3.069	3.790	1.544	1.433	.467
Race/Ethnicity							
White	1857	2662	2.947	3.614	1.552	1.506	.430
Other	295	398	2.319	3.300	1.418	1.506	.692
Parental Education							
Low	1207	1642	2.520	3.319	1.490	1.549	.536
High	1023	1541	3.252	3.878	1.533	1.399	.408
Grade Point Average							
B or lower	1430	1982	2.635	3.386	1.530	1.530	.491
B+ or higher	813	1226	3.216	3.907	1.521	1.412	.454
Truancy							
None	1242	1680	2.976	3.815	1.553	1.423	.540
Some	931	1439	2.652	3.322	1.522	1.555	.440
Evenings Out							
<4/week	1167	1586	2.991	3.776	1.561	1.440	.503
4+/week	1077	1614	2.697	3.414	1.532	1.543	.468
Miles per Week							
<100	1657	2289	2.859	3.640	1.539	1.492	.507
100 or more	599	922	2.820	3.443	1.588	1.536	.392
Illicit Drug Use							
None	1336	2016	3.075	3.788	1.558	1.451	.458
Some	907	1190	2.508	3.261	1.484	1.534	.507

NOTE: Effect size is mean difference divided by "before" standard deviation.

4. Discussion

The policy examined here is a population-wide intervention significantly affecting one of the most important risky

behaviors among teens—driving without a safety belt. Even a modest effect size applied to the entire population results in substantial public health benefits, but this policy provides a considerable effect. The effect sizes of about 0.5 without any adjustment for secular trends are quite large by social science standards. After adjusting for secular trends, the effect sizes are about 0.4, still substantial. As an indication of how substantial the effect is, the data in Table 2 suggest that about 14% more seniors use seat belts after a law change compared to before the change, adjusting for secular trends.

In addition, the effect is seen across youth of all types, including both genders, white and other race/ethnic groups, lower and upper socioeconomic status groups, the more and less academically successful, as well as other characteristics. The policy, now in effect in all U.S. states, is undoubtedly resulting in significant reductions in mortality and morbidity among youth. Although we believe that the results provide convincing evidence that enactment of safety belt laws have important effects, we should acknowledge that the study design is not as strong as it could be for causal inferences. This study takes advantage of a "natural experiment" and does not have rigorous controls for possible contaminating factors. We cannot rule out the possibility that some factors may have led to the passing of a safety belt use law, and that those same factors led to increased safety belt use by youth, and would have done so in the absence of a law change. This seems exceedingly unlikely: the pattern of an immediate and substantial change in belt use after enactment, as shown in Fig. 1, makes it far more likely and certainly more parsimonious that the law changes had the desired effect.

There is, of course, a logical possibility that the changes observed are due to changes in reporting of safety belt use, not in actual behavior. Although there is some evidence that respondents tend to over-report their actual use of safety belts (Block, 2000; Streff & Wagenaar, 1989), it is difficult to believe that students would react to a change in state law by changing very substantially only their reporting but not their actual use behavior. There are also conditions in the present study that might produce over-estimates of safety belt use. Specifically, the present analyses are restricted to students who stayed in high school until near the end of senior year, and who completed a questionnaire. These restrictions likely mean that the sample is probably comprised of individuals who are more likely to use belts than the non-included individuals. This limitation would likely produce an over-estimate of belt use but, because the effect would be essentially constant over time, would not likely affect any changes in reporting.

Although the data reported here indicate considerable increase in safety belt use, it is still the case that many adolescents fail to use safety belts. Among the seniors in the class of 2000, more than a third report that they do not always wear safety belts in the front seat: 12% said that they "often" wear a safety belt when driving, 8% said "sometimes," 7% said "seldom," and another 7% said "never." And because there may be some over-reporting of use, the percentages reporting that they "always" use safety belts in this study may even over-state true percentages to some extent. Clearly, there remains considerable room for improvement. It is likely that primary, rather than secondary, laws would increase safety belt use among adolescents even more than do secondary laws.

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