The Effect of Seat Belt Legislation on Road Traffic Accident Injuries

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outline of the talk

Brief history

Physics and biomechanics of RTA

Seat belt legislation in UK and the world

Effect on mortality and morbidity

Other improvements and hazards

Conclusions

first fatalities

1898 first UK pedestrian death
South London
25th Feb 1899
first passenger fatality
Harrow on the Hill,
Daimler rear wheel collapse,
hit a wall: driver and passenger,
Major Richer thrown from the vehicle
passenger died 3 days later
speed limits 8-14mph

RTAs 1900-40s

increasing fatalities from RTAs

‘not the responsibility of manufacturers’

emphasis on preventing driver’s behaviours;

‘the nut behind the wheel’

1930 plate glass replaced by laminated glass windscreens

2nd WW: pilot harnesses and cockpit strengthening

1950-60s

car crashes ‘survivable’ despite 5 million deaths, speeds increasing

‘style over safety’

Police start traffic investigation 1961

steering wheel injuries

ejection thought desirable rather than hazardous

1950-60s

Genarelli and Patrick start cadaver studies, then animal and human studies

Force of 400G needed to crack a skull (1.5 tons)

Liberty Mutual insurance design a ‘survival car’

GM design a collapsable steering wheel in early 1960s

First seat belts

1959 Volvo 2 point lap, still had high risk of chest impact

3 point belts added protection

Other manufacturers claimed it would ‘increase risky driver behaviour’ and ‘increase injury’


WEL GORDEL

Physics

- Momentum= mv m mass v velocity
- Force = ma a acceleration
- Acceleration= change in velocity vs time
- Kinetic energy= $1/2mv^2$

Evidence for/against seat belts

Experimental: crash test dummies

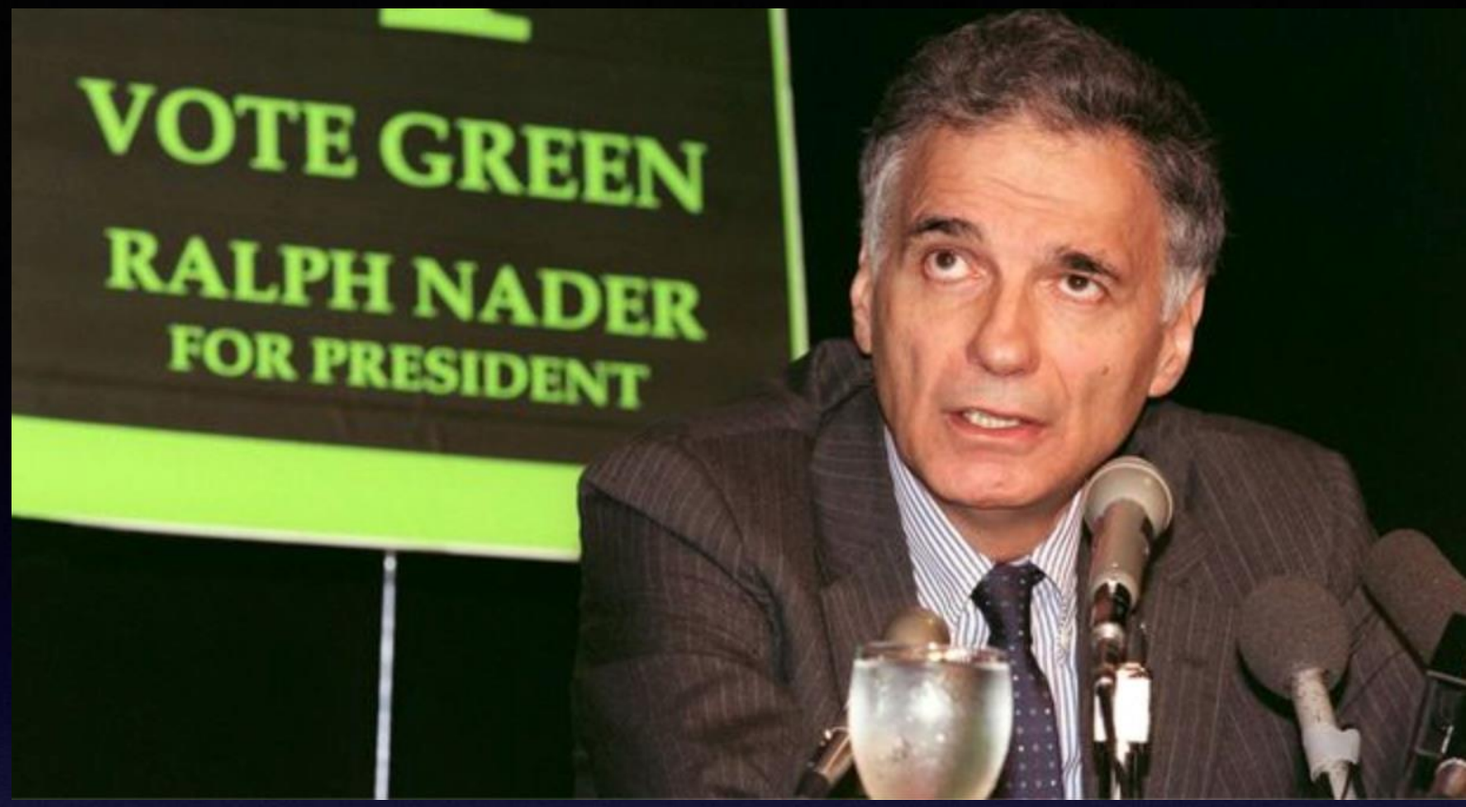
Pre and post legislation RTA casualty figures: UK and US

Trends: seat belt use vs RTA mortality/morbidity

three crashes

- car with object
- driver/passengers with surroundings
- organs with body cavities

Ralph Nader



why did racing drivers wear seat belts and other safety features?

Style over safety:Car maunfacturers did not want the ‘psychosexual aura of the motor car to be tainted by death and destruction’

CEO of GM has to apologise for hiring a private detective to shadow him

Seat belts

- driver seat belt
- front seat passenger
- rear passengers
- lap and fixed belts vs inertia reel belts
- children’s seats
- audio reminders, gearbox controlled seat belts

severe head injury SE Scotland

- 150 per year in 1980s
- 30-40 per year 2015-20
- correlation or causation?

eye, facial and brain trauma; ejection through windscreen

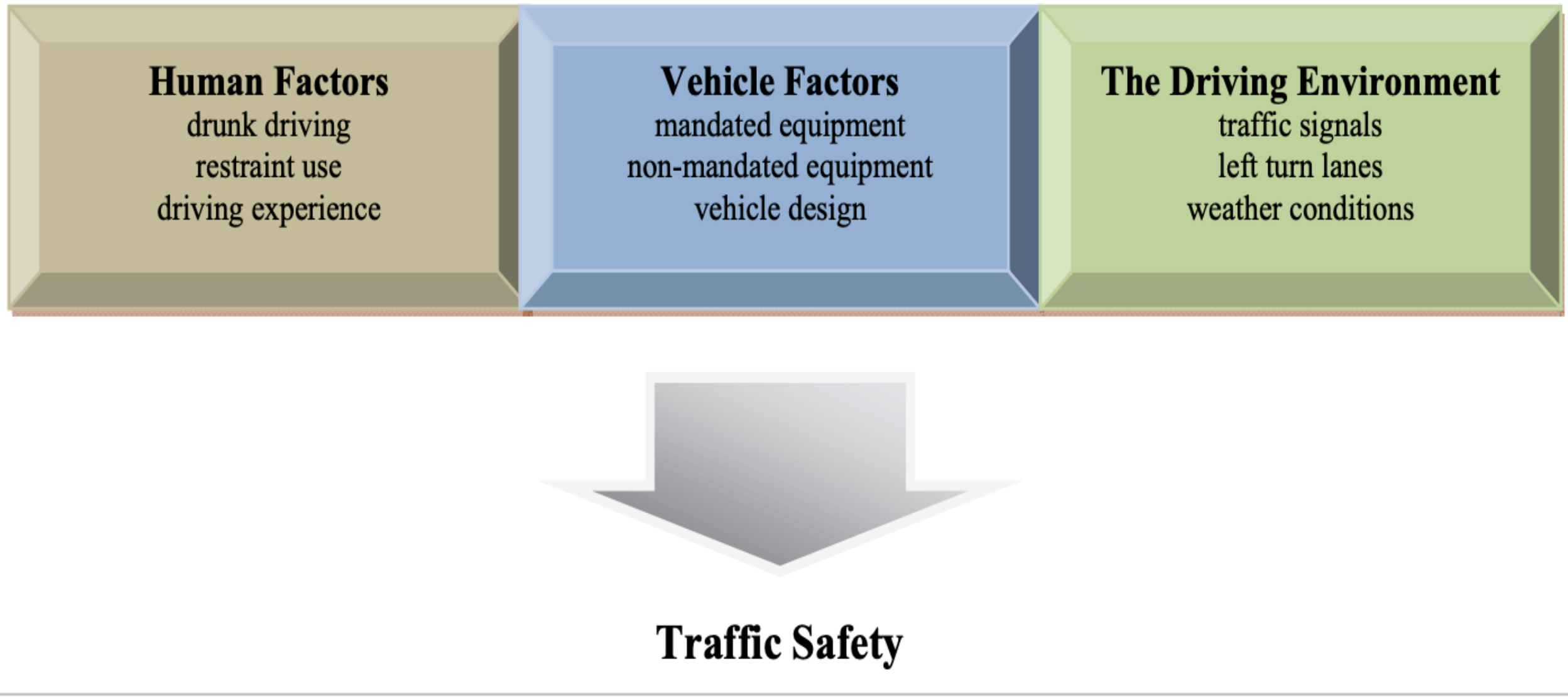


Figure 1-2: Factors Contributing to Traffic Safety

traffic confusion

Change in driver and passenger safety with time

- Drink driving laws
- seatbelt laws: front, rear, rear lap belts, child car seats
- air bags (front), side air bags
- car construction, brakes, and crumple zones; Volvo vs 2 CV
- Road construction
- speed restrictions, and positioning, average speed cameras, traffic light
- use of mobile phones

seat belt legislation

compulsory fitting in new cars, driver, front seat passenger, rear seat passenger, adult, child, infant

compulsory use of fitted belts

primary legislation or secondary legislation

penalties and enforcement

Enforcement

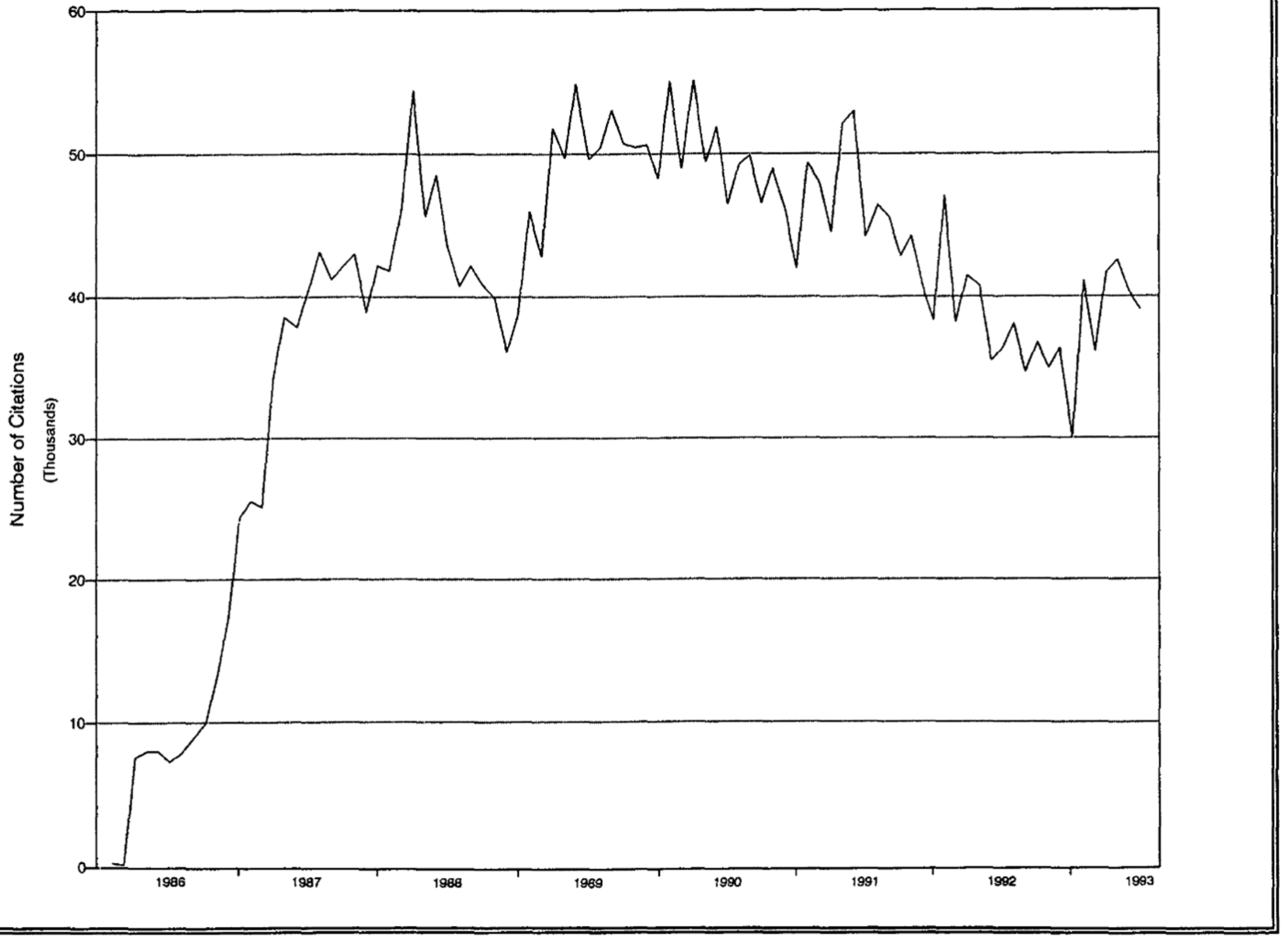


Figure 4. CHP Seat Belt Citations 1986 - June 1993.

Australian law 1971-2

TABLE 3
EFFECTS OF NON-U.S. SEAT BELT LAWS ON FATALITIES

Jurisdiction	Effective Month	Post-law Months	Fatality Change	Investigators
Australia				
Victoria	1/71	9	-15%**	Foldvary & Lane (1974)
		48	-37%	Trinca & Dooley (1977)
		10	-15%	Andreassend (1976)
		12	-15%	Joubert (1979)
		84	***	McDermott & Hough (1979)
		144	-60%	Trinca (1984)
Queensland	1/72		-14%	Johinke (1977)
			-46%	Bhattacharyya & Layton (1979)
South Australia	11/71	12	-8%	Crinion et al. (1975)
Australia (overall)			-20%	Fisher (1980)

Contemporary Themes

Non-fatal injuries sustained by seatbelt wearers: a comparative study

M S CHRISTIAN

British Medical Journal, 1976, **2**, 1310-1311

Summary

The injuries sustained by 969 drivers and front-seat passengers in road-traffic accidents were studied. Altogether 196 (20·2%) of the drivers and passengers were wearing seat belts and 773 (79·8%) were not. The injuries among the two groups differed greatly in both severity and distribution. A total of 54 (27·6%) of the seatbelt wearers sustained one or more fractures compared with 300 (38·8%) of the non-wearers, and 18 (9·2%) of the seat-belt wearers were severely injured compared with 300 (38·8%) of the non-wearers. Soft-tissue injuries to the face were sustained by only 29 (14·8%) of the seatbelt wearers compared with 425 (55%) of the non-wearers.

Since wearing seatbelts may become compulsory, the type and pattern of injuries to be expected in wearers should be appreciated.

BMJ 1976 Christian

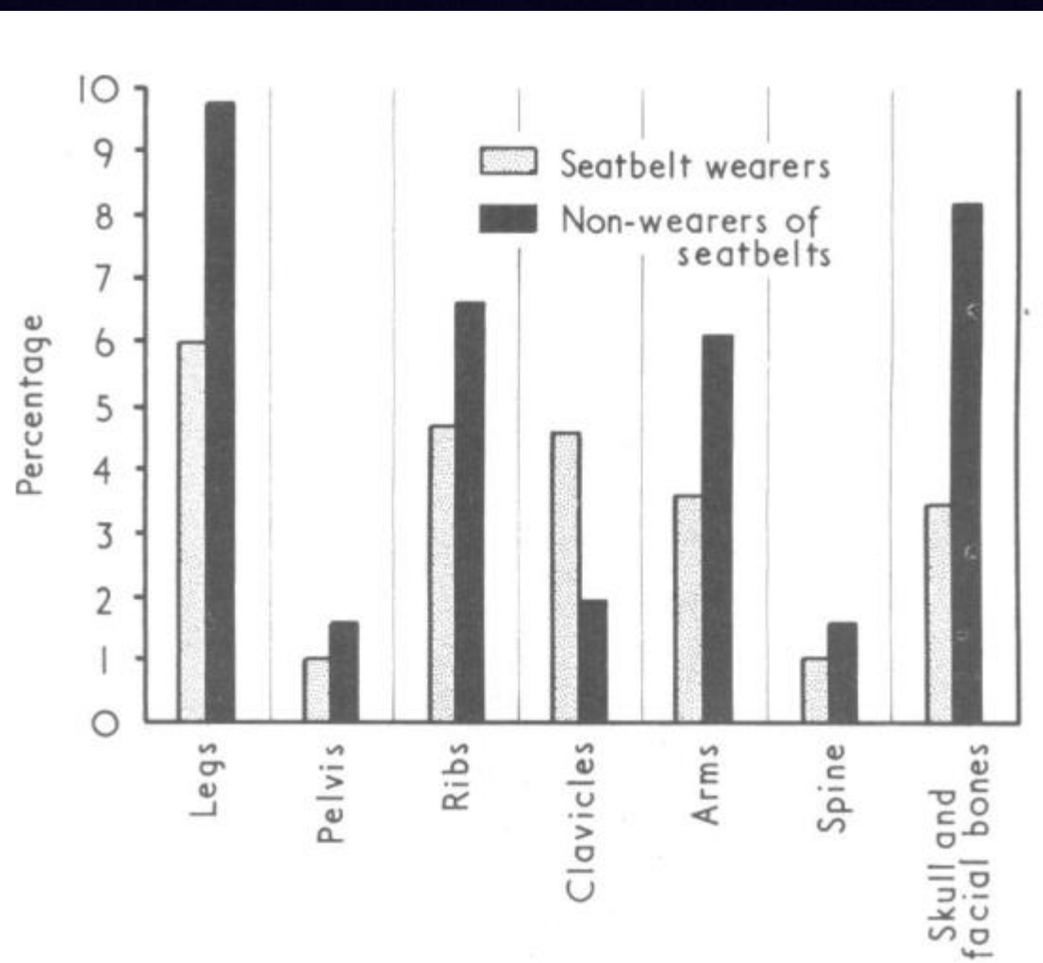


FIG 1—Percentage distribution of fractures and dislocations sustained by wearers and non-wearers of seatbelts.

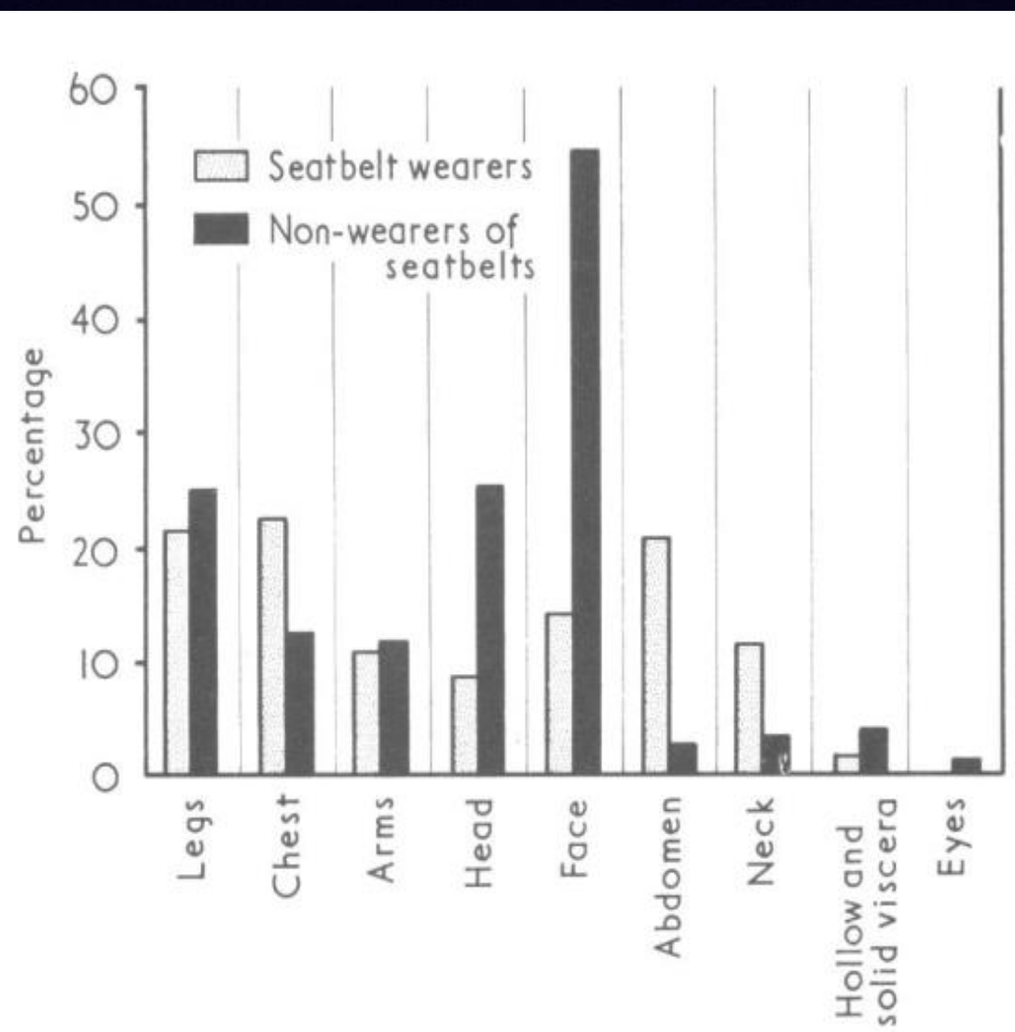
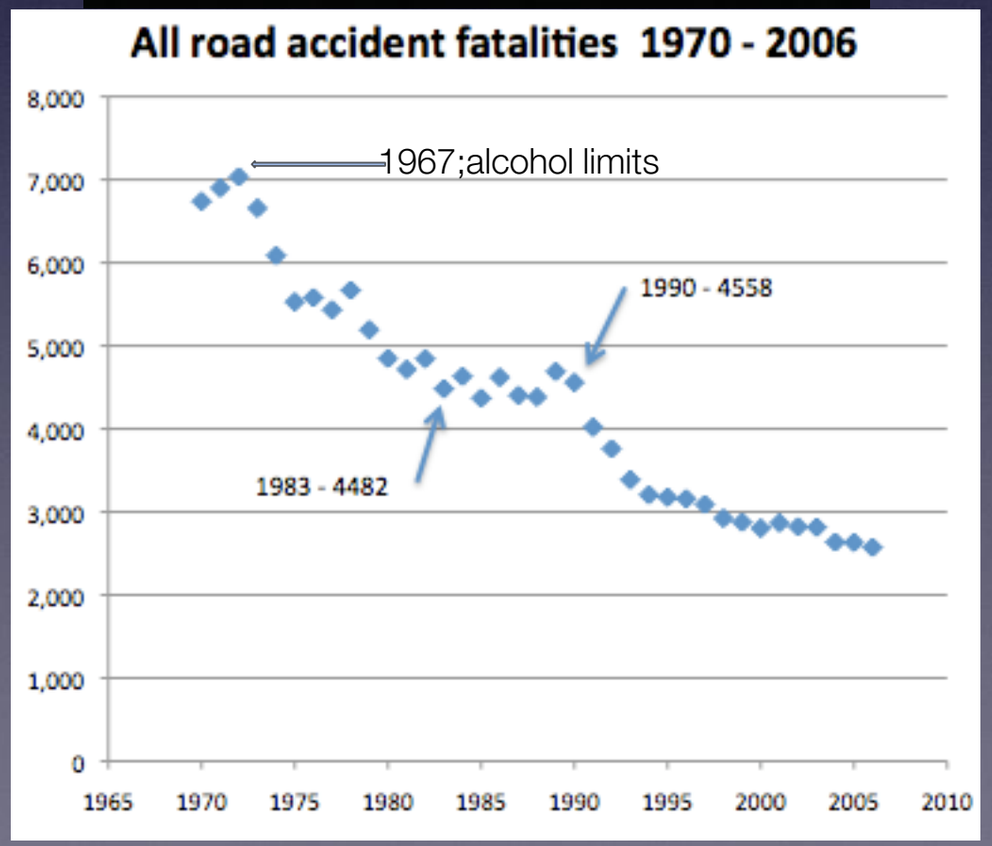


FIG 2—Percentage distribution of soft-tissue injuries sustained by wearers and non-wearers of seat belts.

UK seat belt legislation

- Volvo 3 point seat belt 1959
- 1965-68 compulsory seat belt fitting in all cars UK
- Jan 31st 1983 compulsory use of front seat belts
- rear seat belts 1986-91
- 2006 child restraints for <135cm height



Pye and Waters BMJ 1984

Non-fatal injuries sustained by car drivers and passengers in road traffic accidents in Nottingham before and after seat belt legislation

Severity of injuries*	No of injuries		Fall (%)	Significance†
	Nov-Jan	Feb-April		
Facial injuries				
Mild	72	24	67	$p<0.001$
Moderate	11	2	81	$p<0.025$
Severe	10	0	100	$p<0.01$
Total	93	26	72	$p<0.001$
Head injuries				
Mild	66	30	55	$p<0.001$
Moderate	17	0	100	$p<0.001$
Severe	6	3	50	NS
Total	89	33	63	$p<0.001$
Neck injuries				
Mild	38	23	39	NS
Moderate	3	0	100	NS
Severe	7	1	86	$p<0.05$
Total	48	24	50	$p<0.01$
Chest injuries				
Mild	19	27		NS
Moderate	4	1	75	NS
Severe	8	1	88	$p<0.025$
Total	31	29	6	NS
All injuries				
Mild	245	133	46	$p<0.001$
Moderate	29	7	76	$p<0.001$
Severe	21	2	90	$p<0.001$
Total	295	142	52	$p<0.001$

*Assessed with injury severity score.[3]
†Using χ^2 test.

Reductions in moderate and severe injuries were greater than average for all four anatomical sites. Few deaths occurred in the accident and emergency department; the number of deaths for the whole of Nottinghamshire fell significantly from 15 to three (80%) ($p<0.01$). (Statistics of Nottinghamshire road safety department, 1983. Unpublished observation.)

Injury (1985) **16**, 471–476 *Printed in Great Britain*

The effect of seat belt legislation on injuries sustained by car occupants

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Leicester Royal Infirmary

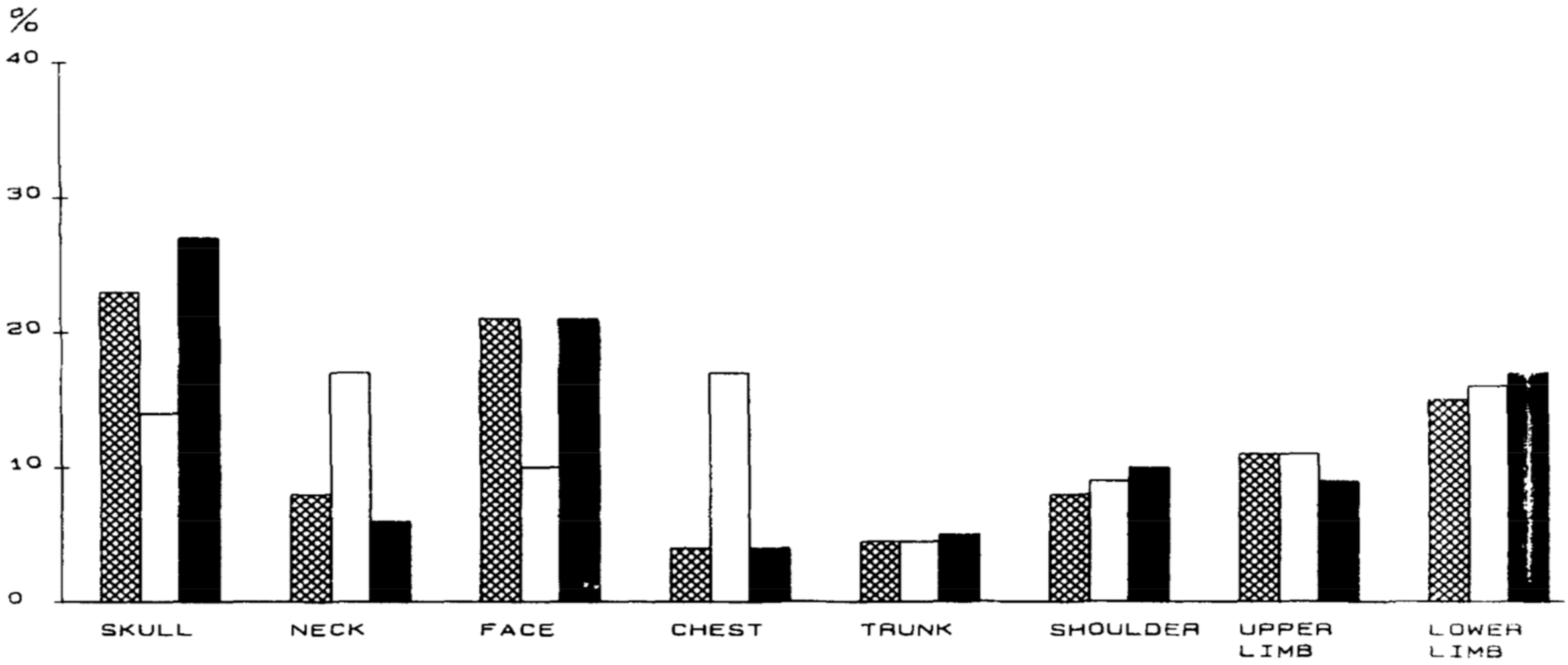


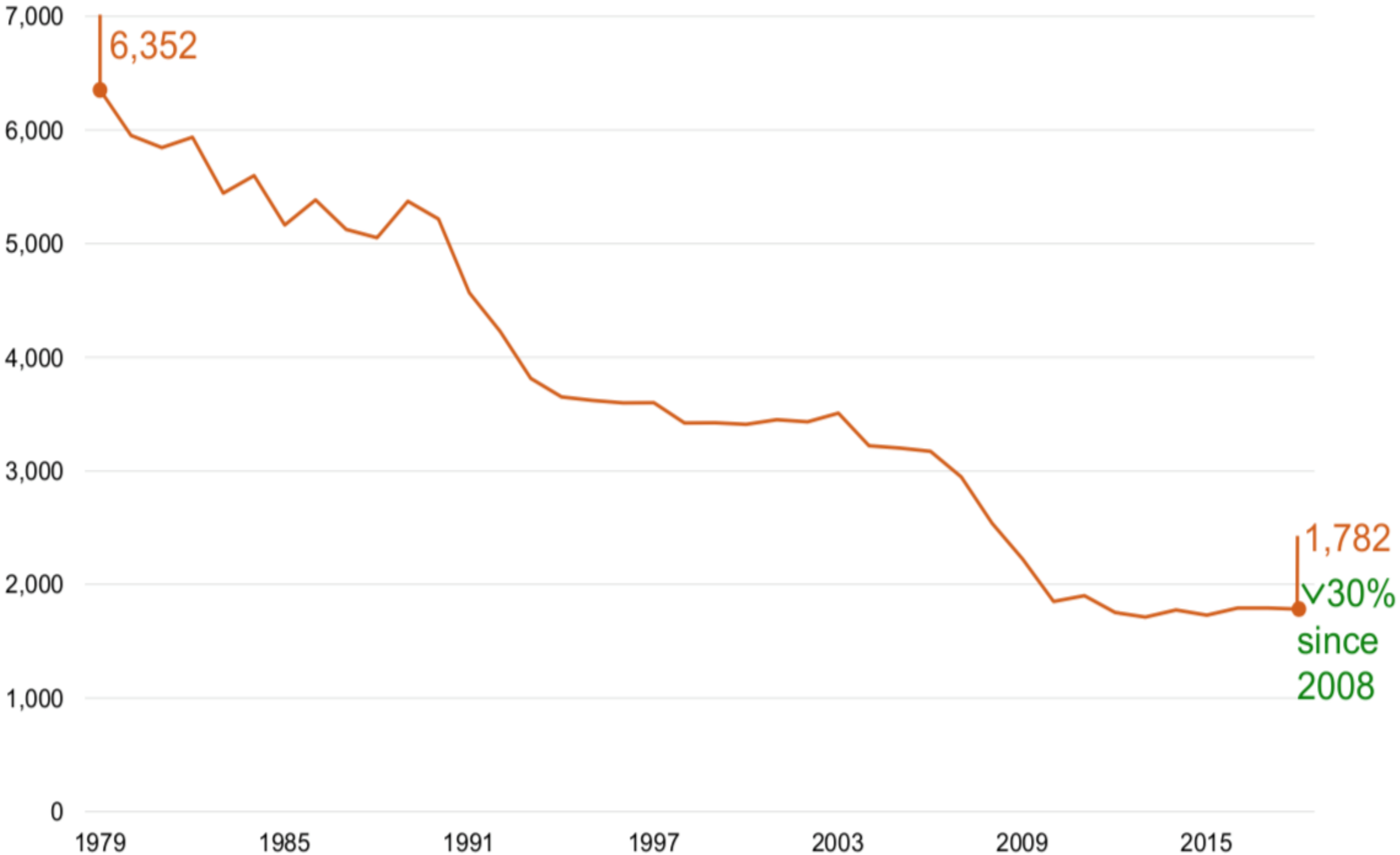
Fig. 7. Percentage distribution of injuries according to site. □, seat belts worn; ▨, seat belts not worn; ■, back seat passengers.

Allen 1985 Leicester

Table II. Numbers of injuries

	No. of persons injured	*No. of injuries*	*Injuries/person*
Drivers			
Seat belt worn	209	328	1·56
No seat belt	193	418	2·17
Front seat passengers			
Seat belt worn	91	131	1·4
No seat belt	118	266	2·25
Back seat passengers			
No seat belt	147	231	1·57

Chart 2: Fatalities in reported road accidents: GB, 1979-2018



Accid. Anal. & Prev. Vol. 18, No. 3, pp. 229–241, 1986
Printed in Great Britain.

0001-4575/86 $3.00 + .00

THE EFFECTIVENESS OF SAFETY BELTS IN PREVENTING FATALITIES

LEONARD EVANS
General Motors Research Laboratories, Warren, MI 48090

(*Received* 1 *July* 1985; *in revised form* 14 *January* 1986)

Abstract—The effectiveness of safety belts in preventing fatalities to drivers and right front passengers is estimated by applying the double pair comparison method to 1974 or later model year cars coded in the Fatal Accident Reporting System. The method focuses on "subject" occupants (drivers or right front passengers) and "other" occupants (any except the subject occupant). Fatality risks to belted and unbelted subject occupants are compared using the other occupant to estimate exposure. In this study, drivers and right front passengers are subject occupants; choosing other occupants differing in age, seating positions, and belt use, generated 46 essentially independent estimates of safety belt effectiveness. The weighted average and standard error of these is (41 ± 4)%. This finding agrees with the 40%–50% range reported in a recent major review and synthesis by the National Highway Traffic Safety Administration. Combining this with the present determination gives (43 ± 3)%; that is, if all presently unbelted drivers and right front passengers were to use the provided three point lap/shoulder belt, but not otherwise change their behavior, fatalities to this group would decline by (43 ± 3)%.

Evans FARS data 1986 17000 accidents, 1974 cars

Table 12. Overall estimate of fatality reduction if all drivers and right front passengers were belted (compared to none belted)

subject occupant	number killed	fraction of total	effectiveness results from Table 11 E%	ΔE%	Percent, P, of fatalities prevented	ΔP(%)
driver	112 579	0.760	42.1	3.8	31.99	2.89
right front passenger	35 564	0.240	39.2	4.3	9.41	1.03
Total	148 143	1.000			41.40	

Overall fatality reduction if all drivers and right front passengers wore belts (compared to none wearing) = (41.4 * 3.8)%

The Impact of Texas State Legislation on the Use of Safety Belts

Barbara A. Brillhart, PhD RN; Hazel M. Jay, MS RN

This study was a survey on the impact of the Texas safety belt law. Observations were conducted before the law's enactment; after enactment of the law without penalty fee; and one month and twelve months after enactment of the law with penalty fee. Results of the study indicate a significantly higher rate of safety belt compliance following the enactment of the law. Female drivers were consistently more compliant with wearing safety belts. Young male drivers were the least compliant with the new law. Rehabilitation nurses share public concern with this health promotion issue due to the large number of spinal cord and head injuries which directly result from the nonuse of safety belts.

146/May-Jun 88/Rehabilitation Nursing/Vol. 13, No. 3

Table 1. Percentages of Compliance with Safety Belt Legislation

Sex	1st observations	2nd	3rd	4th
Grocery/Store				
F	17.46%	50.00%	71.74%	63.63%
M	10.42%	43.68%	55.05%	55.55%
Hospital				
F	22.50%	46.90%	64.38%	66.43%
M	12.66%	31.70%	51.22%	52.45%
High school				
F	13.71%	36.30%	50.90%	51.19%
M	7.72%	15.58%	34.30%	35.33%
University				
F	28.57%	48.45%	72.48%	67.57%
M	26.42%	33.06%	57.55%	45.16%
Interstate highway exit				
F	52.47%	25.81%	78.18%	82.76%
M	25.87%	13.87%	54.06%	50.97%

female n = 2,527
male n = 3,747
total n = 6,274

1st observation — prior to the safety belt law
2nd observation — after the safety belt law, no penalty fee
3rd observation — after the safety belt law, with penalty fee
4th observation — one year after the safety belt law, with penalty fee

Figure 1. Percentage of Safety Belt Compliance Prior to the Law

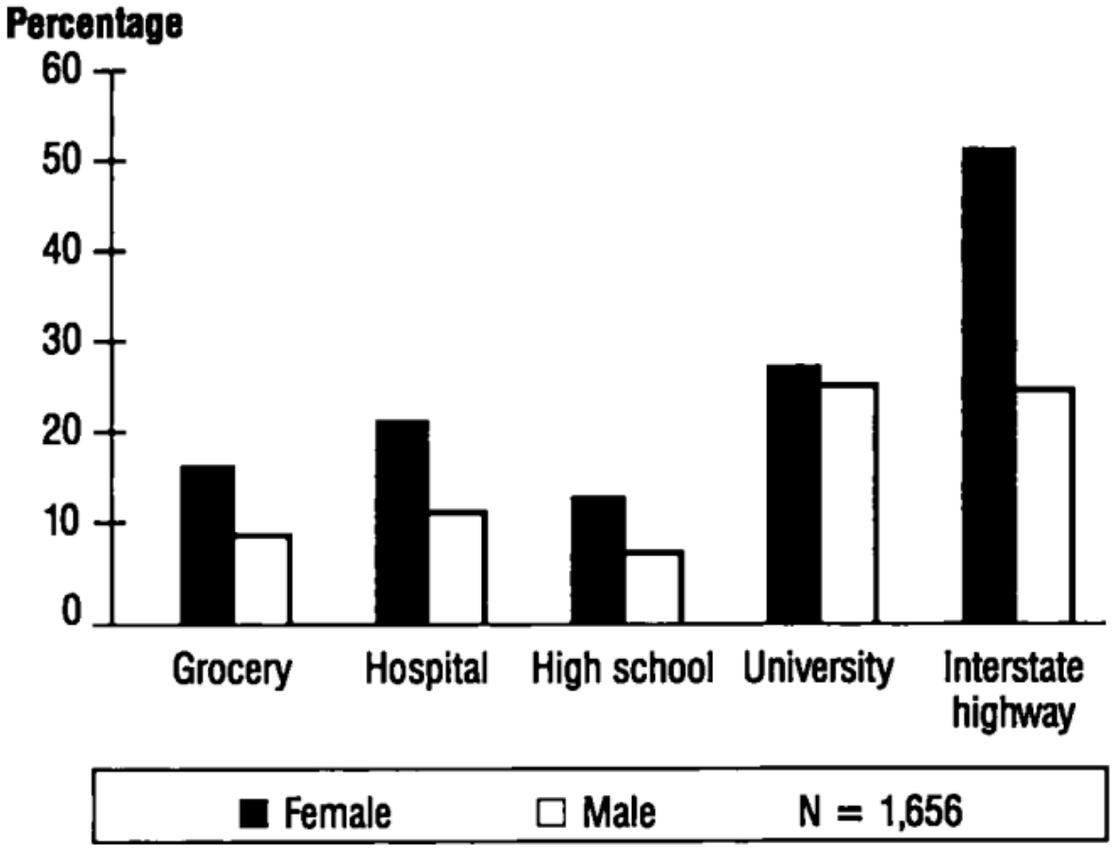


Figure 2. Percentage of Safety Belt Compliance After the Law Without Penalty Fee

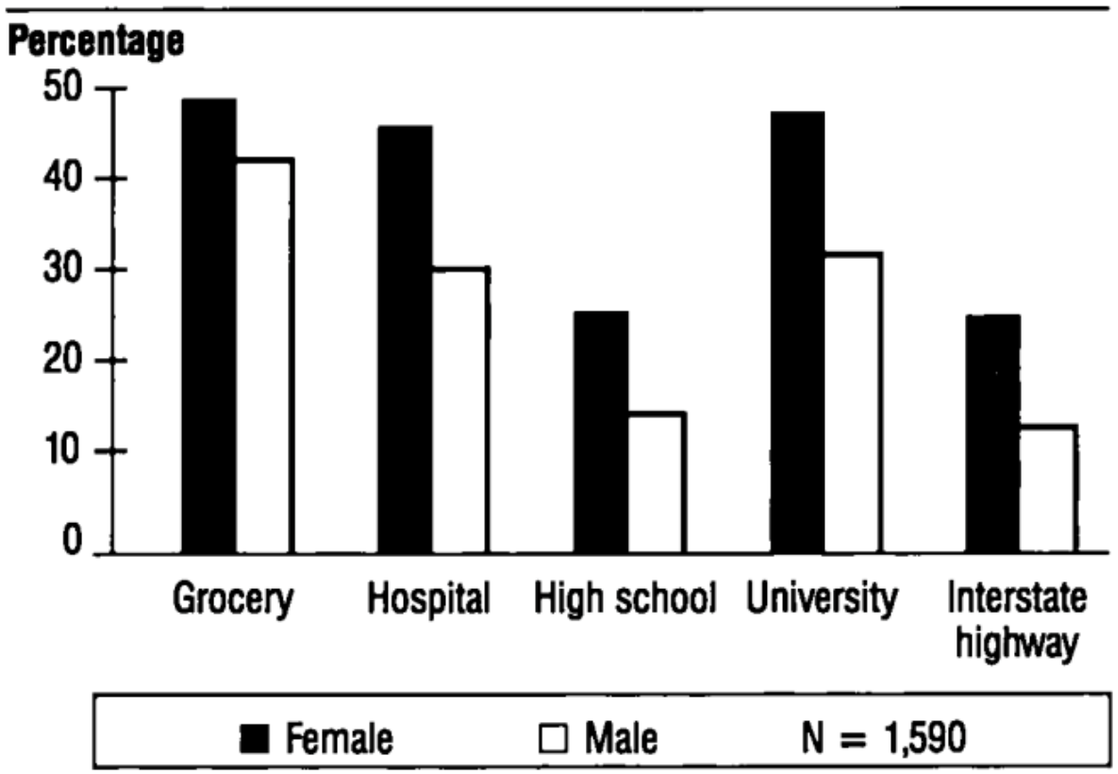


Figure 3. Percentage of Safety Belt Compliance After the Law With Penalty Fee

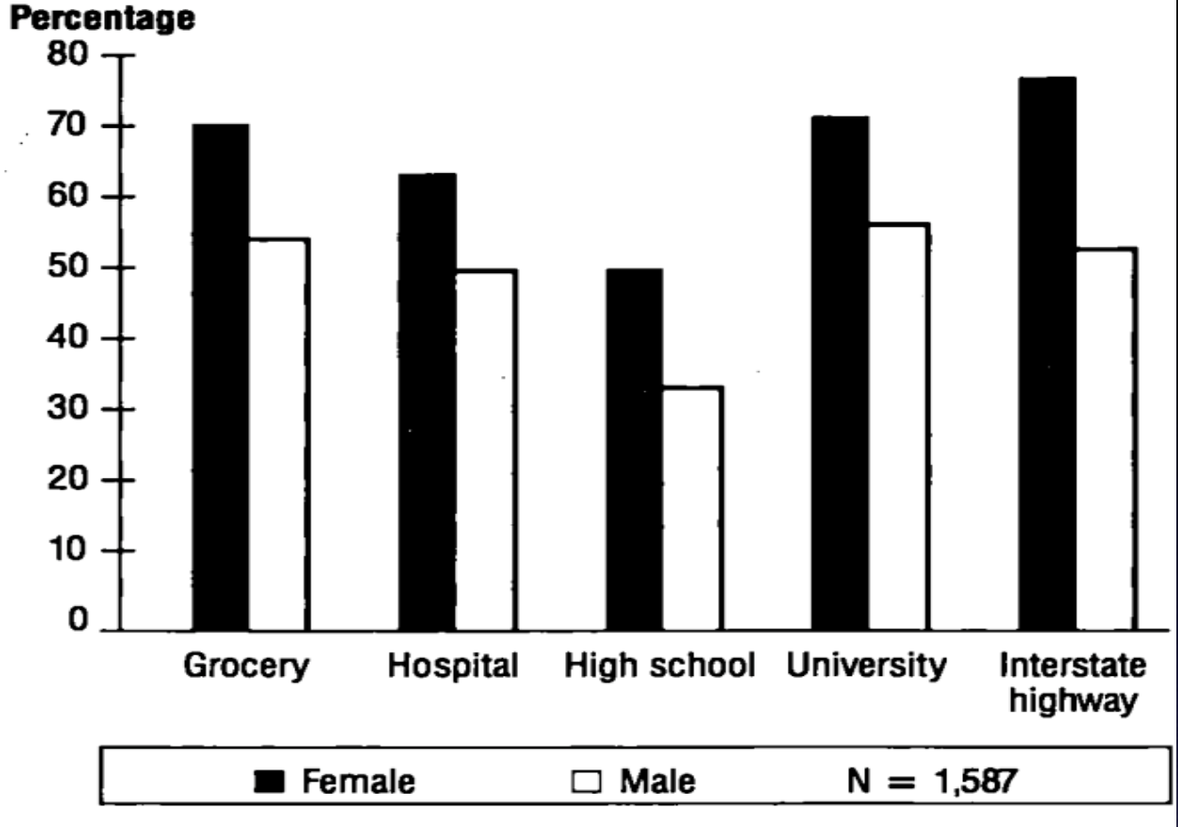
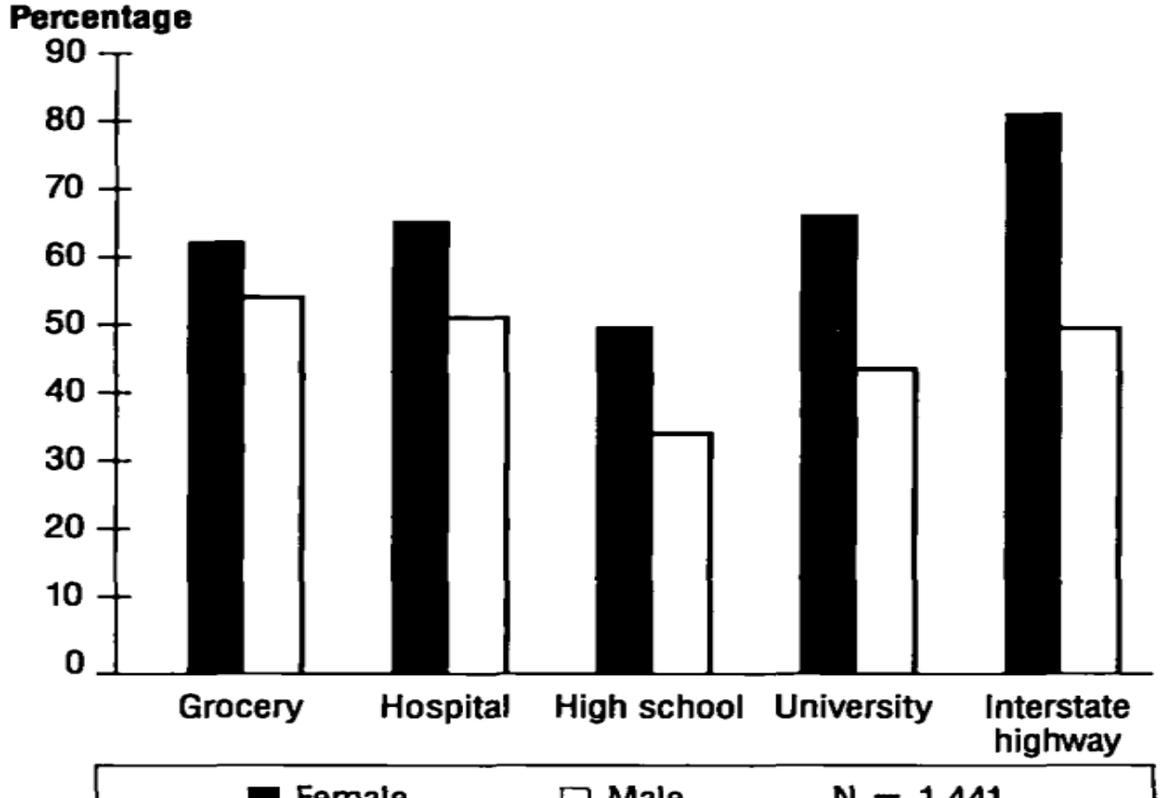


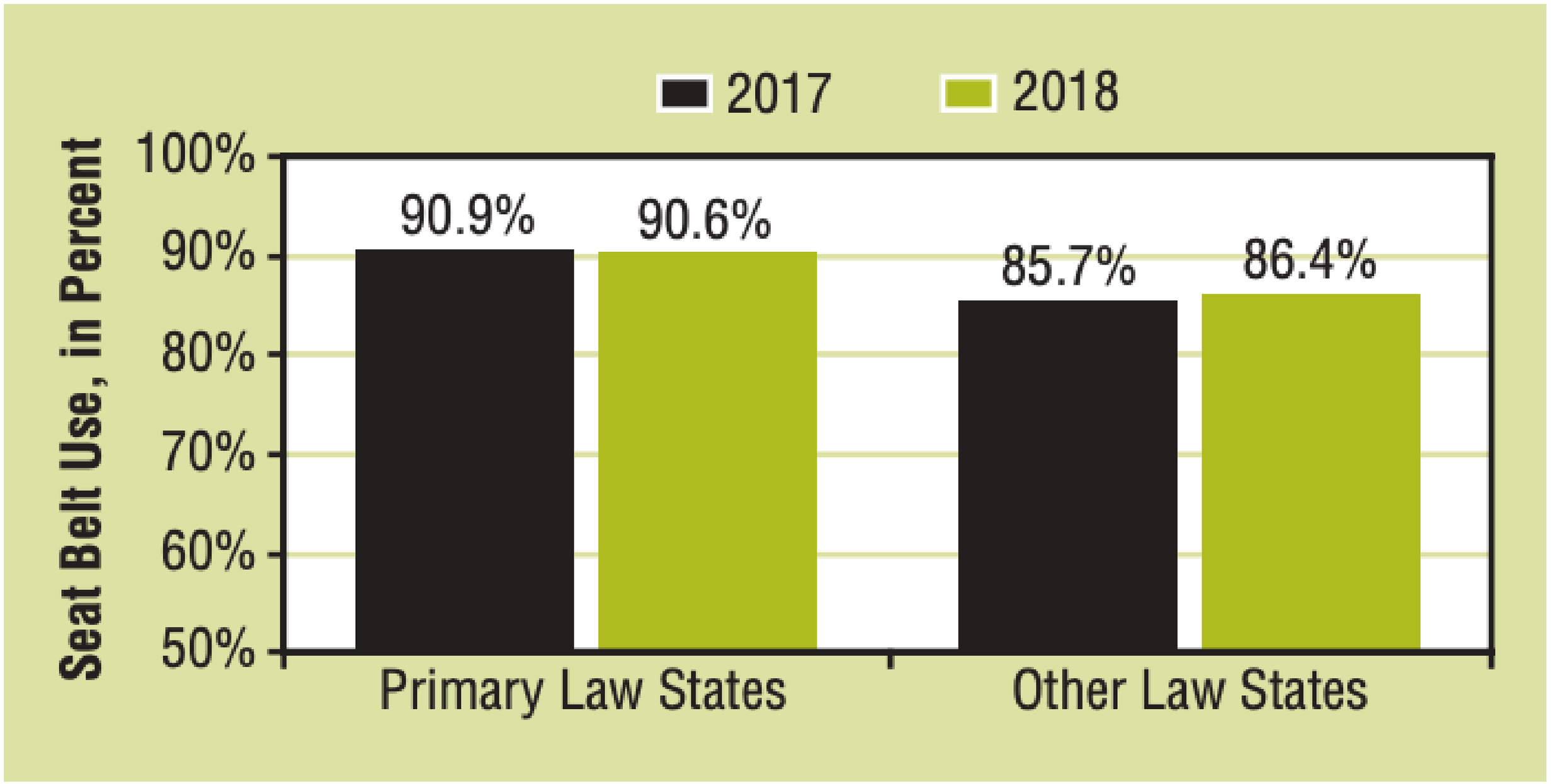
Figure 4. Percentage of Safety Belt Compliance One Year After the Law With Penalty Fee



US laws

On January 23, 1997, President Bill Clinton directed the Secretary of Transportation to develop a plan to increase the use of seat belts throughout the nation. This Presidential Initiative for Increasing Seat Belt Use Nationwide set goals of improving seat belt use from 68% in 1996 to 85% by 2000 and 90% by 2005. It was estimated that meeting the 2005 goal would prevent 5536 fatalities and 132 670 injuries, resulting in an annual economic saving of $8.8 billion. A key provision in the four-point plan is the adoption of primary seat belt laws by the states (NHTSA, 2001b). Furthermore, the 1998 TEA-21 legislation (P.L. 105-178) created incentive grants to induce states to adopt primary enforcement provisions (NHTSA, 1998).

Seat Belt Use by Law Type

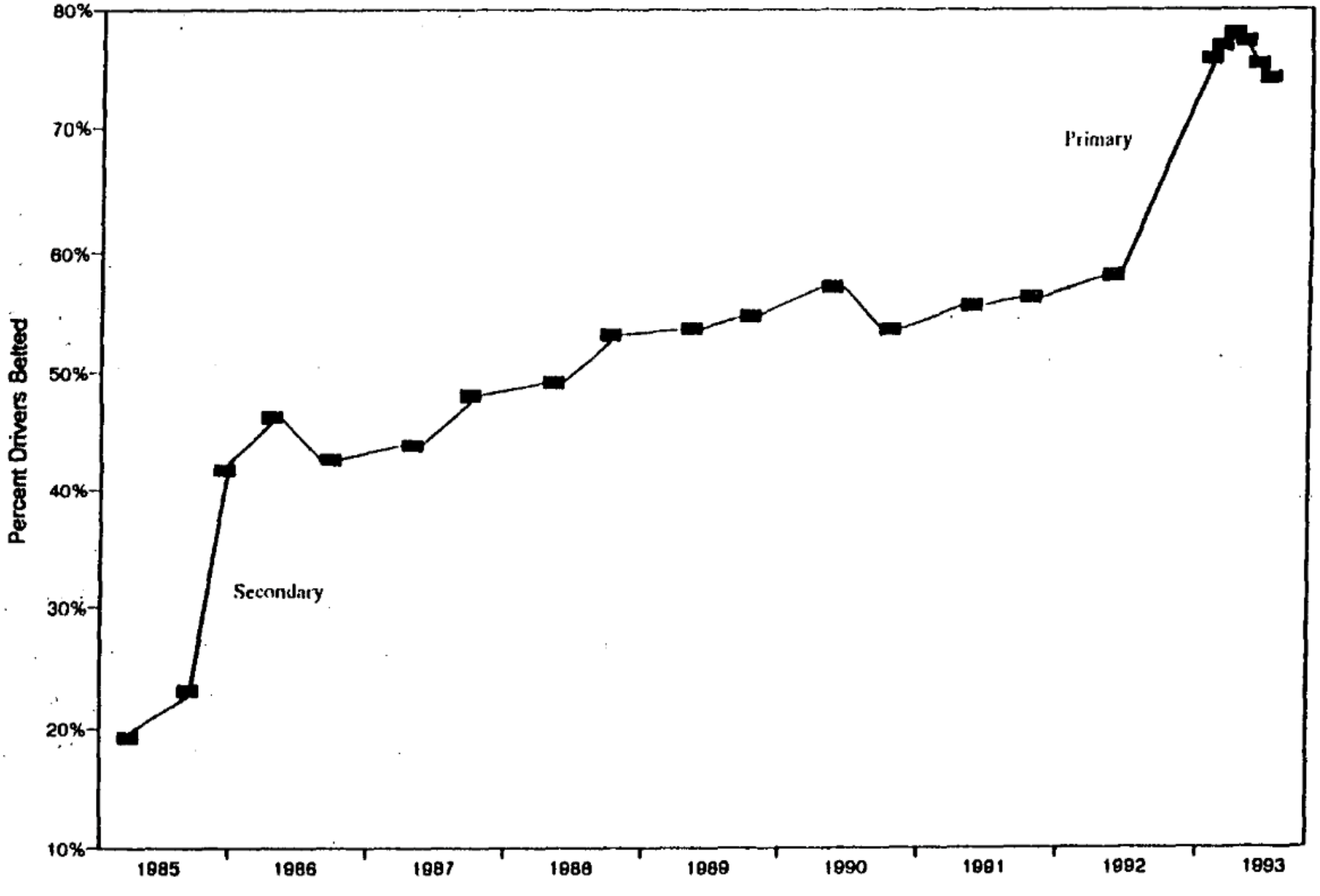


Source: NOPUS

Table 1. Status of state seat belt legislation enforcement provisions[a]

Original laws with primary enforcement	Belt laws changed to primary enforcement	Primary enforcement bill proposed in state legislature from 1998 to May 2001
New York, 1984	California, 1993	Arizona, 1998, 2001
Hawaii, 1985	Louisiana, 1995	Colorado, 1998, 1999, 2000
North Carolina, 1985	Georgia, 1996	Delaware, 1998, 1999, 2000, 2001
Texas, 1985	Maryland, 1997	Florida, 1998, 1999, 2000, 2001
Connecticut, 1986	District of Columbia, 1997	Illinois, 1999, 2000, 2001
Iowa, 1986	Oklahoma, 1997	Kansas, 2000, 2001
New Mexico, 1986	Indiana, 1998	Kentucky, 2001
Oregon, 1990	Alabama, 1999	Maine, 2001
	Michigan, 1999	Massachusetts, 2000, 2001
	New Jersey, 2000	Minnesota, 1998, 1999, 2000, 2001
		Mississippi, 1998, 1999, 2000, 2001
		Missouri, 2000, 2001
		Montana, 2001
		Nebraska, 1999, 2000, 2001
		Ohio, 1999, 2000, 2001
		South Carolina, 1998, 1999, 2000, 2001

Population Weighted Average Belt Use
Six Cities 1985 - 1993.



Journal of Safety Research, Vol. 19, pp. 51–70, 1988

0022-4375/88 $3.00 + .00
Printed in the USA

Mandatory Seat Belt Laws in Eight States: A Time-Series Evaluation

Alexander C. Wagenaar, Richard G. Maybee, and Kathleen P. Sullivan

We examined state-specific and aggregate effects of U.S. legislation requiring the use of seat belts among front-seat motor vehicle occupants. Effects of compulsory seat belt use on the number of occupants fatally injured in traffic crashes were examined in the first eight states adopting such laws. Monthly data on crash fatalities between January 1976 and June 1986 were analyzed using Box-Tiao intervention analysis time-series methods. Because the new laws apply only to front-seat occupants, front-seat occupant fatalities were compared with: (1) rear-seat fatalities; (2) nonoccupant fatalities (motorcyclists, pedalcyclists, pedestrians); and (3) fatalities among front-seat occupants in neighboring states without compulsory seat belt use. Exposure to risk of crash involvement was controlled by analyzing fatality rates per vehicle mile traveled. Results revealed a statistically significant decline of 8.7% in the rate of front-seat fatalities in the first eight states with seat belt laws. The fatality rate declined 9.9% in states with primary enforcement laws and 6.8% in states with secondary enforcement only. Rates of rear-seat and nonoccupant fatalities did not change when the belt laws were implemented.

TABLE 4
EFFECTS OF U.S. SEAT BELT LAWS ON FATALITITES

Jurisdiction	Effective Month	Post-law Months	Fatality Change	Investigators
New York	12/84	9	-9%**	Lund, Pollner, & Williams (1986)
		9	-15%+	Hedlund (1986)
		6	-20%+	Latimer & Lave (1987)
		3	-27%	Pace et al. (1986)
		13	-5%***	Lund, Zador, & Pollner (1986)
		13	-8%*	Campbell et al. (1986)
		19	-7%	Hoxie & Skinner (1987)
New Jersey	3/85	10	-4%	Lund, Zador, & Pollner (1986)
		10	-6%*	Campbell et al. (1986)
		16	-2%	Hoxie & Skinner (1987)
Michigan	7/85	12	-10%	Wagenaar, Maybee, & Sullivan (1987)
		6	-4%	Lund, Zador, & Pollner (1986)
		6	-16%*	Campbell et al. (1986)
		12	-14%*	Hoxie & Skinner (1987)
Illinois	7/85	9	-3%+	Mortimer (1986)
		6	-7%	Lund, Zador, & Pollner (1986)
	7/86	6	-9%	Campbell et al. (1986)
		12	-1%	Hoxie & Skinner (1987)

FIGURE 1
PERCENT CHANGE IN RATE OF FATALITIES PER VMT
ASSOCIATED WITH SEAT BELT LAWS:
FRONT-SEAT OCCUPANTS AGE 10 AND OVER

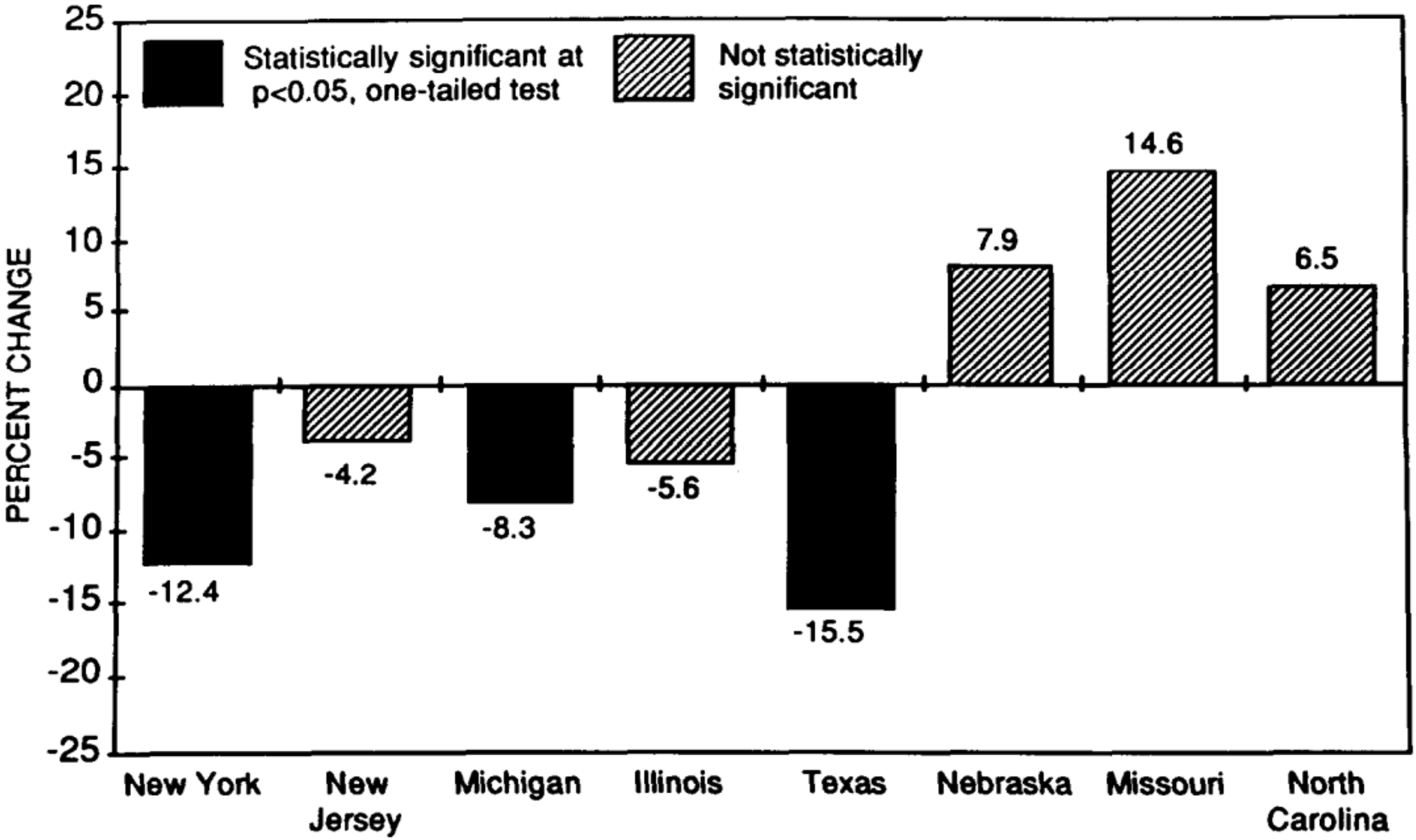


FIGURE 2
PERCENT CHANGE IN RATE OF FATALITIES PER VMT
AMONG FRONT-SEAT OCCUPANTS AGE 10 AND OVER:
BELT-LAW STATES RELATIVE TO COMPARISON STATES

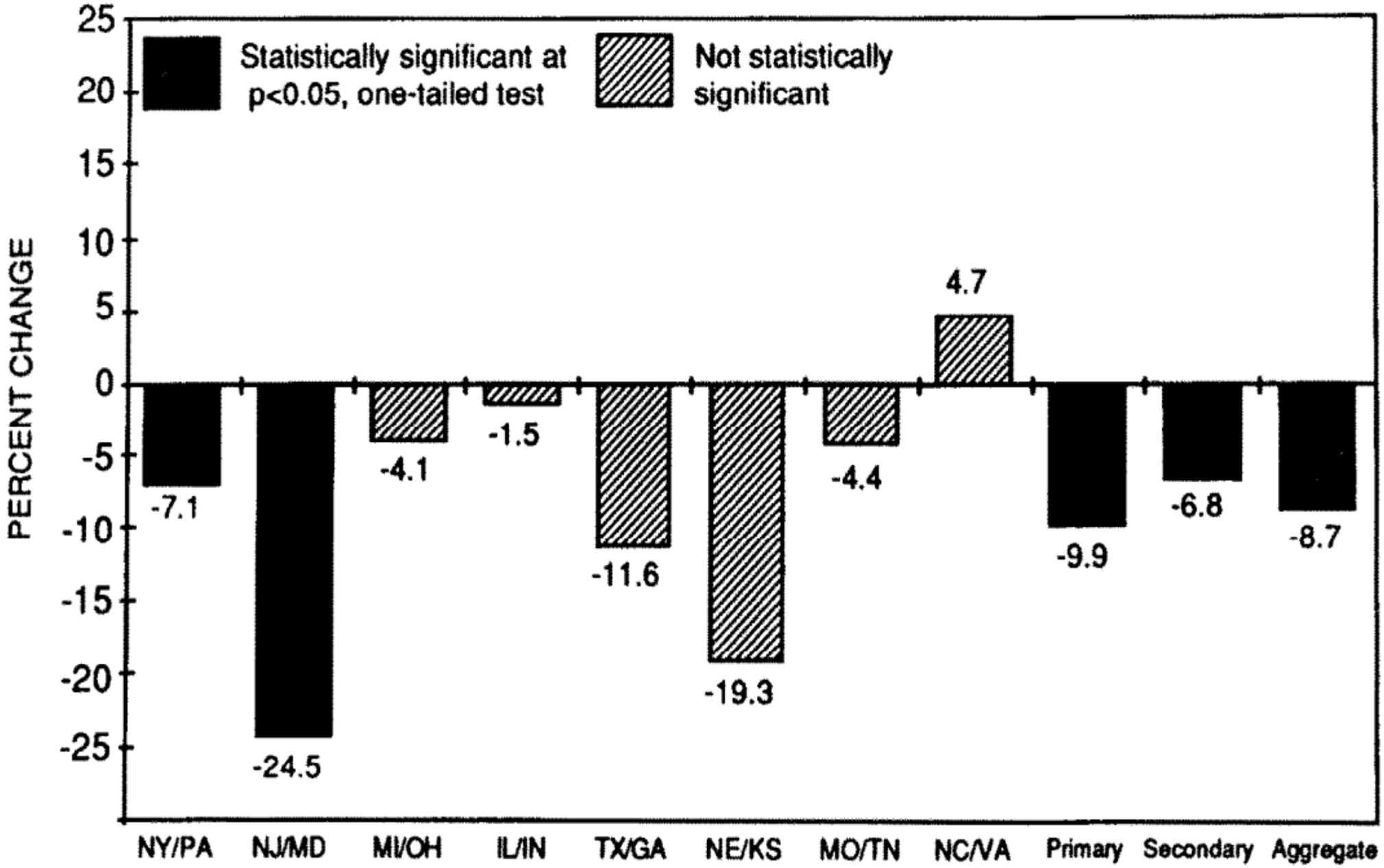


TABLE 5
MONTHLY FATALITY RATE MEANS AND STANDARD DEVIATIONS
BEFORE AND AFTER MANDATORY SEAT BELT LAWS

Comparison	Prelaw		Postlaw	
	Mean	SD	Mean	SD
Rate of front-seat fatalities per VMT				
New York	158.14	32.79	113.87	22.39
New Jersey	116.63	21.30	99.63	14.40
Michigan	165.84	36.06	132.76	26.90
Illinois	168.42	38.61	123.25	17.07
Texas	213.45	34.39	139.70	9.01
Nebraska	182.26	61.46	155.61	38.09
Missouri	201.77	45.75	189.31	26.08
North Carolina	211.44	37.45	201.84	22.76
Relative rate of front-seat fatalities per VMT				
New York vs. Pennsylvania	.95	.14	.75	.11
New Jersey vs. Maryland	.89	.24	.78	.19
Michigan vs. Ohio	1.07	.21	.97	.19
Illinois vs. Indiana	1.10	.35	.84	.14
Texas vs. Georgia	1.14	.23	.88	.18
Nebraska vs. Kansas	1.01	.44	.84	.24
Missouri vs. Tennessee	1.17	.32	.89	.21
North Carolina vs. Virginia	1.40	.33	1.46	.22
Aggregate relative rate of front-seat fatalities per VMT				
Eight belt-law vs. eight comparison states	1.07	.09	.89	.04
Aggregate rate of rear-seat fatalities per VMT				
Eight belt law states	12.48	3.18	9.54	1.24
Aggregate rate of nonoccupant fatalities per VMT				
Eight belt law states	66.92	18.21	41.90	3.92
Aggregate rate of front-seat fatalities per VMT by Enforcement provision				
Primary enforcement	191.14	29.48	128.76	8.86
Secondary enforcement	153.59	25.39	121.19	13.98

Accid. Anal. & Prev. Vol. 23, No. 1, pp. 87–93, 1991
Printed in Great Britain.

0001-4575/91 $3.00 + .00

CHANGE IN INJURIES ASSOCIATED WITH SAFETY BELT LAWS

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University of North Carolina Highway Safety Research Center, 134 1/2 East Franklin Street, CB #3430, Chapel Hill, NC 27599-3430, U.S.A.

(*Received* 26 *July* 1989; *in revised form* 20 *March* 1990)

Abstract—Statewide crash data bases from nine states were subjected to time series analyses to detect changes in injuries associated with onset of seat belt laws in the respective states. In each of 18 analyses involving drivers covered by the law observed casualties were below the number forecast on the basis of prior experience and assuming that no law had been enacted. In the case of others, not covered by the law, observed injuries were equally often above or below forecast. Relative to covered drivers not only were the numbers below forecast, but in 12 of the 18 instances there was a statistically significant indication of an abrupt decrease the month the law began.

Accid. Anal. & Prev. Vol. 25, No. 2, pp. 189–197, 1993
Printed in the U.S.A.

0001-4575/93 $6.00 + .00

THE EFFECTIVENESS OF SEAT BELT LEGISLATION IN REDUCING VARIOUS DRIVER-INVOLVED INJURY RATES IN CALIFORNIA*

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Department of Economics, Rutgers University, Newark, NJ 07102, U.S.A.

(*Received* 19 *February* 1991; *in revised form* 20 *December* 1991)

Abstract—This study makes use of econometric models to examine the impact of seat belt laws on various driver-involved injury rates in California in both single- and multiple-vehicle accidents. The study makes use of a large data set from the U.S. D.O.T. State Traffic Accident Files and accounts for the general impact of seat belt laws as well as their dynamic effects on injury rates. The models adjust for a wide range of additional contributing factors to injury rates, including the influence of unemployment rates, speed limits, companion effects, and others. Robust results are obtained for the efficacy of seat belt legislation on reducing (moderate to fatal) injury rates in California.

Journal of Safety Research Vol. 21, pp. 9-18, 1990

0022-4375/90 $3.00 + .00
Printed in the USA

Reductions in Police-reported Injuries Associated with Michigan's Safety Belt Law

Fredrick M. Streff, Alexander C. Wagenaar, and Robert H. Schultz

This research measured the effects of Michigan's compulsory safety belt use law on traffic crashes and injuries of various severities. Using time-series methods, the authors analyzed monthly frequencies of crash-induced injuries and fatalities from January 1978 through December 1987. Exposure to risk of occupant injury was controlled statistically by including aggregate frequency of crashes as a covariate in time-series models. Effects of economic conditions on traffic crashes were controlled by including an index of unemployment as a covariate. The following statistically significant effects were associated with the safety belt law: (a) In crashes with minor vehicle damage, there was a 14.6% reduction in B-level injuries, an 11.0% reduction in C-level injuries, and a 13.0% reduction in aggregate (KABC) injuries; (b) in crashes with moderate vehicle damage, there was a 16.8% reduction in A-level injuries, an 11.6% reduction in B-level injuries, a 10.7% reduction in C-level injuries, and a 3.6% reduction in aggregate (KABC) injuries; (c) in crashes with severe vehicle damage, there was a 6.3% reduction in fatalities, an 11.8% reduction in B-level injuries, a 4.7% reduction in c-level injuries, and a 5.8% reduction in aggregate (KABC) injuries; (d) for all vehicle damage severities, there was a 14.0% reduction in B-level injuries, an 8.3% reduction in C-level injuries, and a 6.4% reduction in injuries to front-seat occupants. Based on these results, Michigan's adult safety belt law has prevented 31,710 injuries from July 1985 through December 1988.

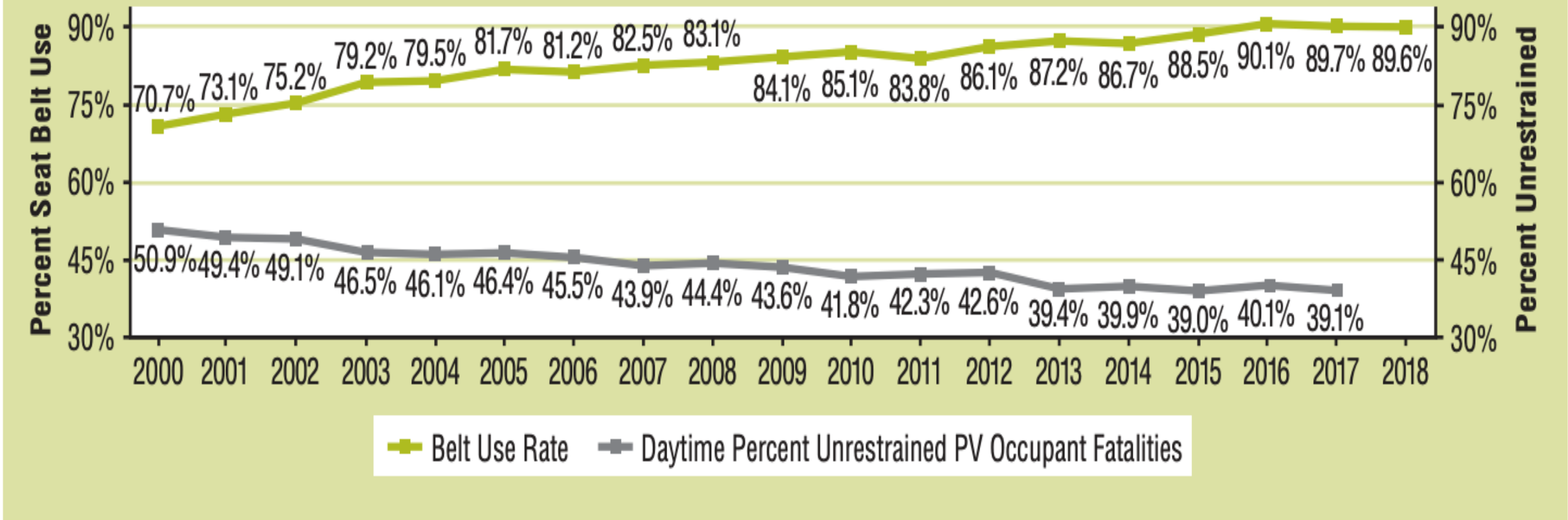
Table 3: Characteristics That Raise the Odds of a Front-Seat Fatality Occurring Within a GES Crash

Characteristic	Odds Ratio	p-value
Speed limit ≥ 55 mph	2.639	0.0001
Single-vehicle crash	2.480	<0.0001
Night crash	1.535	0.0001
Rollover-involved crash	3.450	<0.0001
Head-on crash	10.327	<0.0001
Curved roadway	2.235	<0.0001
Good weather	1.624	0.0022
Unbelted	5.549	<0.0001
Source: NHTSA/NCSA/GES/SUDAN		

belt use vs fatalities

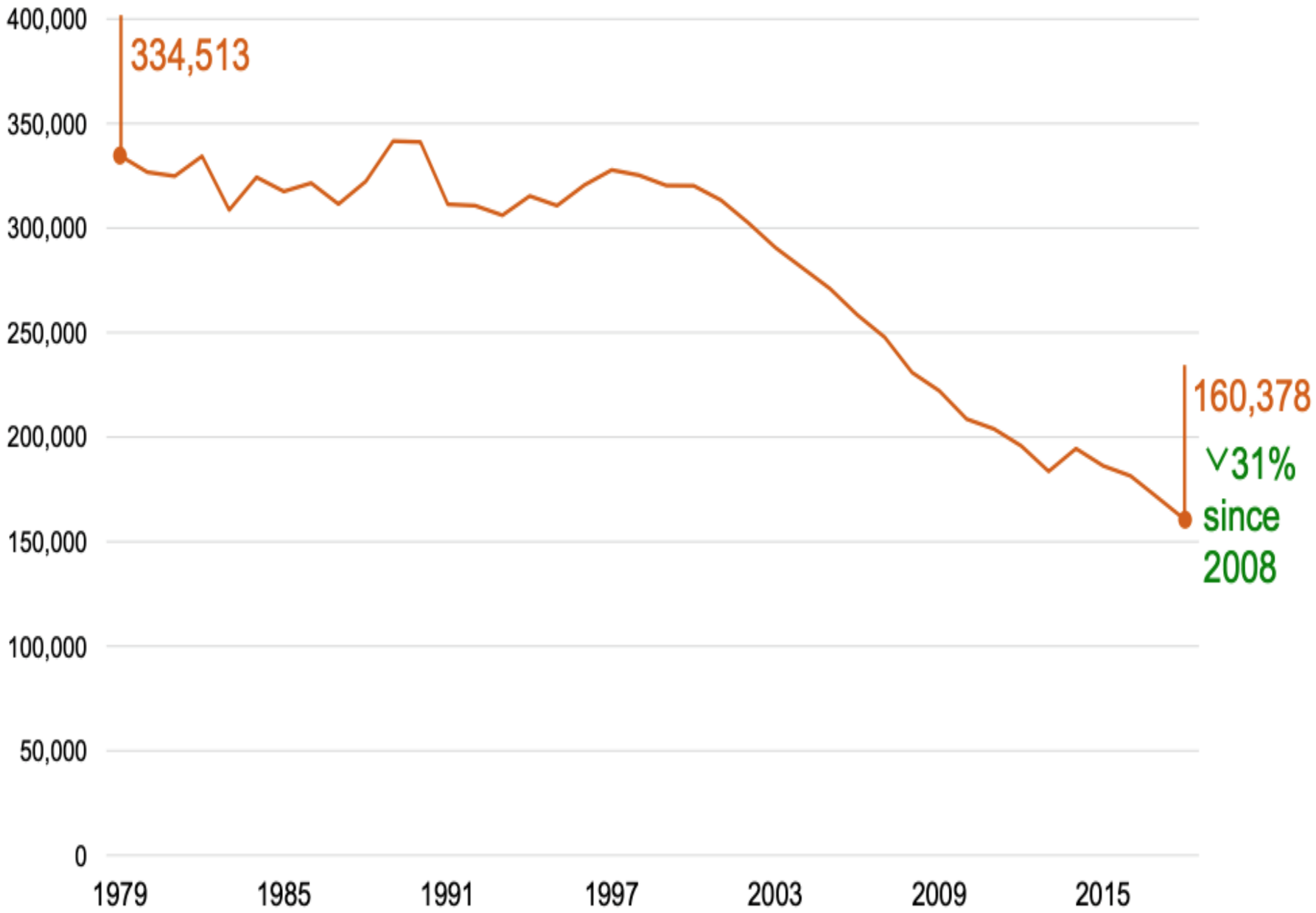
Figure 1

National Seat Belt Use Rate and Daytime Percentage of Unrestrained Passenger Vehicle Occupant Fatalities



Source: NOPUS and FARS

Chart 5: Casualties in reported road accidents: GB, 1979-2018



The long term trend in the number of casualties in reported road accidents has been broadly flat from 1979 to 1998, allowing for natural variation in the number of casualties. Since 1998 there has been a downward trend in the number of casualties.

Injuries per 1000 collisions

Table 6-4: Average Reductions in the Likelihood of Death, Incapacitation, and Injury Between the Model Year 2000 and 2008 Fleets, Treating All Occupant Classes Equally

Feature		*% Change in P(death)*		*% Change in P(incapacitated)*		*% Change in P(injury)*	
		Car	**LTV**	**Car**	**LTV**	**Car**	**LTV**
Crash Type	Frontal	-4%	-2%	-9%	-16%	-8%	-11%
	Near Side	-11%	-8%	-16%	-13%	-15%	-15%
	Far Side	-9%	-13%	-18%	-18%	-15%	-13%
	Rollover	10%	22%	4%	4%	0%	0%
	Other	-23%	-18%	-23%	-22%	-16%	-17%
Driver Alcohol	Sober driver	-11%	-6%	-17%	-17%	-14%	-14%
	Non-sober driver	-3%	-1%	-10%	-11%	-8%	-8%
	No driver	4%	0%	53%	47%	23%	26%
Restraint Use	Restrained	-15%	-10%	-15%	-15%	-9%	-9%
	Unrestrained	2%	5%	-9%	-11%	-11%	-14%
Occupant Age	< 14 Years	-5%	-3%	-17%	-20%	-14%	-16%
	14-24 Years	-2%	2%	-8%	-5%	-9%	-8%
	25-65 Years	-11%	-8%	-11%	-17%	-9%	-13%
	> 65 Years	-10%	-6%	-15%	-13%	-11%	-9%
Occupant Gender	Female	-7%	-4%	-13%	-13%	-10%	-10%
	Male	-7%	-3%	-12%	-13%	-11%	-12%

We note that the absence of interaction terms involving model year and gender indicates that crashworthiness improvements have been similar for men and women.[112]

Fatally Injured Passenger Vehicle Occupants by Type of Vehicle, Restraint Use and Ejection Status, 2003

Vehicle Type by Restraint Use		Ejection Status								Total	
		Not Ejected		Totally Ejected		Partially Ejected		Unknown			
		Number	%	Number	%	Number	%	Number	%	Number	%
Passenger Car	Used	9,309	95%	236	2%	208	2%	38	0%	9,791	100%
	Not Used	6,271	65%	2,708	28%	634	7%	56	1%	9,669	100%
	Total	15,580	80%	2,944	15%	842	4%	94	0%	19,460	100%
Light Truck - Pickup	Used	1,607	94%	30	2%	70	4%	4	0%	1,711	100%
	Not Used	2,123	51%	1,632	39%	403	10%	35	1%	4,193	100%
	Total	3,730	63%	1,662	28%	473	8%	39	1%	5,904	100%
Light Truck - Utility	Used	1,410	89%	90	6%	83	5%	5	0%	1,587	100%
	Not Used	1,004	35%	1,624	57%	210	7%	20	1%	2,859	100%
	Total	2,414	54%	1,714	39%	293	7%	25	1%	4,446	100%
Light Truck - Minivan	Used	655	92%	32	5%	20	3%	1	0%	708	100%
	Not Used	400	51%	325	41%	64	8%	2	0%	791	100%
	Total	1,055	70%	357	24%	84	6%	3	0%	1,499	100%
Light Truck - Van	Used	816	93%	40	5%	24	3%	1	0%	882	100%
	Not Used	601	51%	484	41%	95	8%	5	0%	1,184	100%
	Total	1,417	69%	524	25%	119	6%	6	0%	2,066	100%
Light Truck - Other	Used	7	100%	0	0%	0	0%	0	0%	7	100%
	Not Used	9	45%	8	40%	3	15%	0	0%	20	100%
	Total	16	59%	8	30%	3	11%	0	0%	27	100%
Total	Used	13,142	94%	393	3%	384	3%	48	0%	13,968	100%
	Not Used	10,015	56%	6,459	36%	1,346	8%	117	1%	17,936	100%
	Total	23,157	73%	6,852	21%	1,730	5%	165	1%	31,904	100%

Source: NCSA FARS 2003 Annual Report File

Note: Totals may not equal previously reported totals as occupants whose restraint use was coded as "Unknown" were pro-rated between the restraint used and unused categories. The pro-rated fatality counts have been rounded to the nearest integer. Percents do not add up to 100% across columns due to independent rounding.

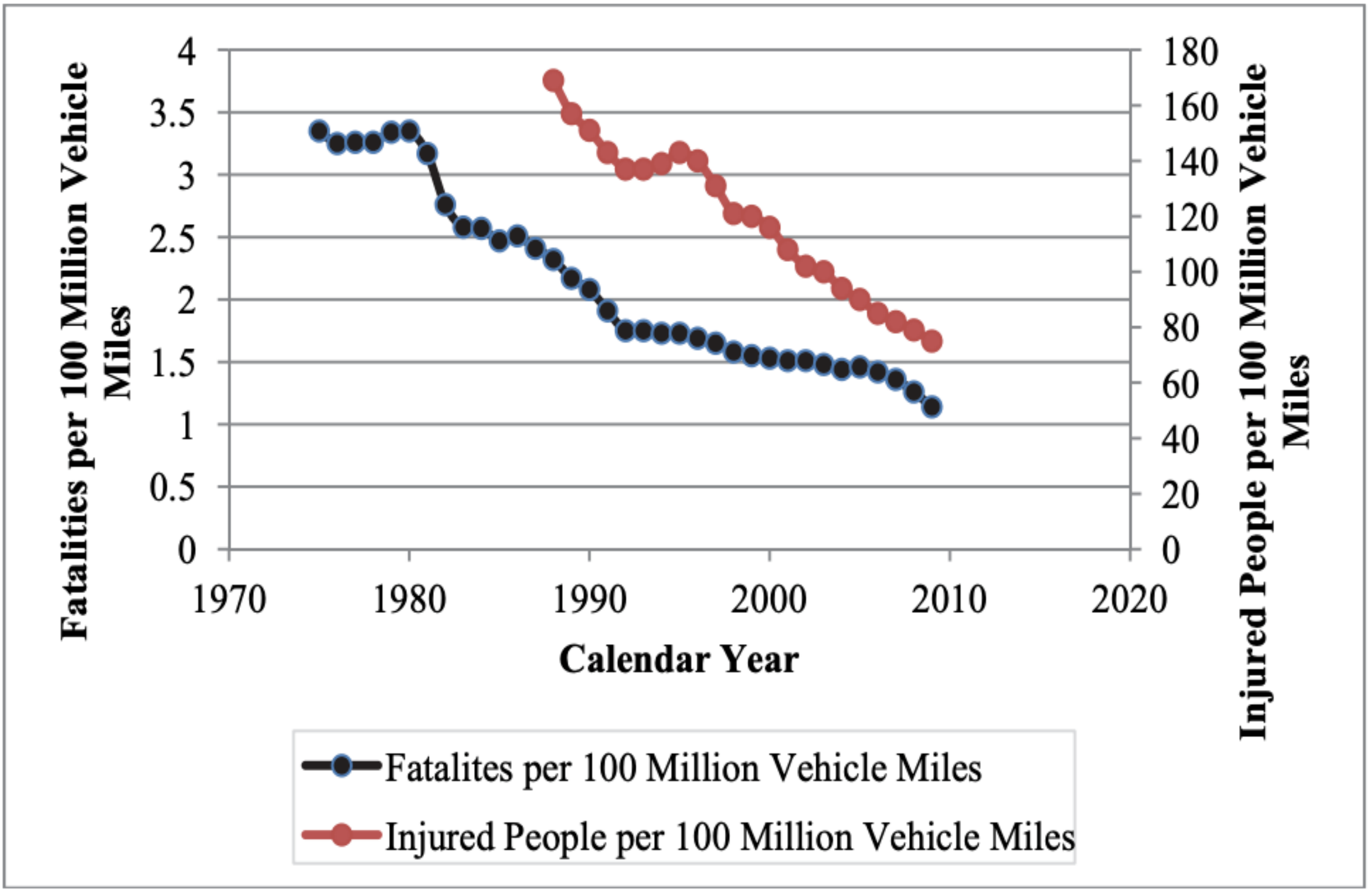


Figure 1-1: Fatalities and People Injured per 100 Million Miles Traveled

seat belt use by gender

Figure 3 shows the trends of seat belt use for male and female occupants over a period of 12 years (2006 to 2017). In 2017 seat belt use continued to be lower for males (88.0%) than females (91.8%). There was no significant change in seat belt use by female or male occupants from 2016 to 2017.

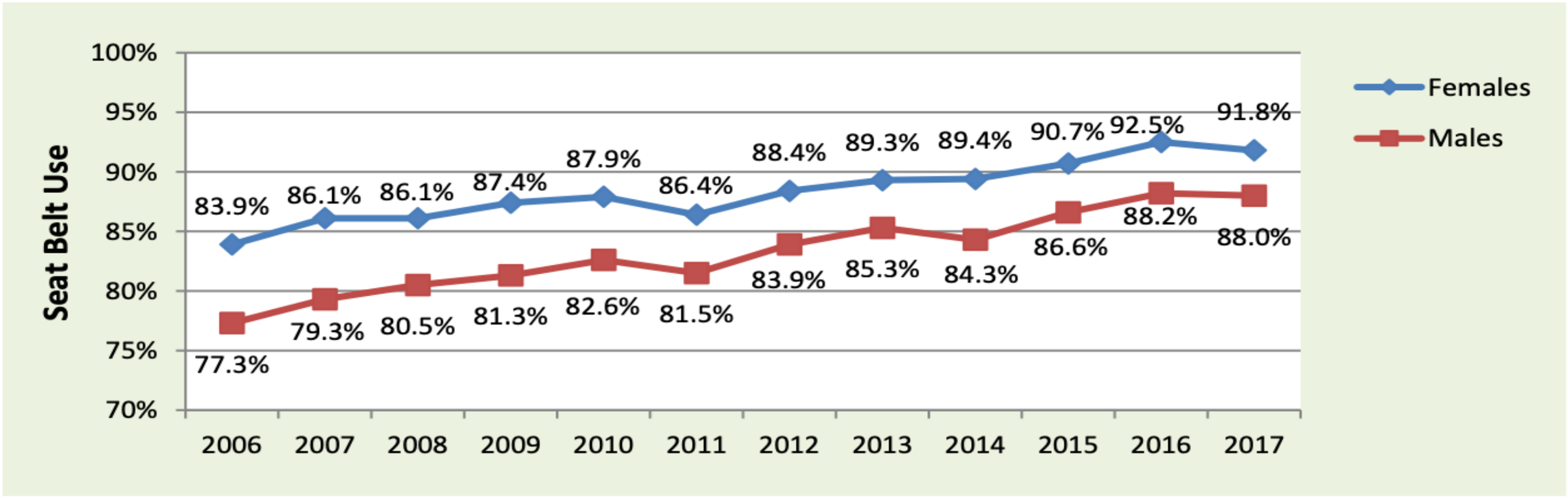


Figure 3: Seat Belt Use by Gender for Occupants 8 and Older, 2006-2017

passenger presence and seat belt use

Presence of Passengers and Seat Belt Use

Figure 5 shows that seat belt use continued to be lower for drivers driving alone than for drivers driving with at least one passenger in the vehicle.

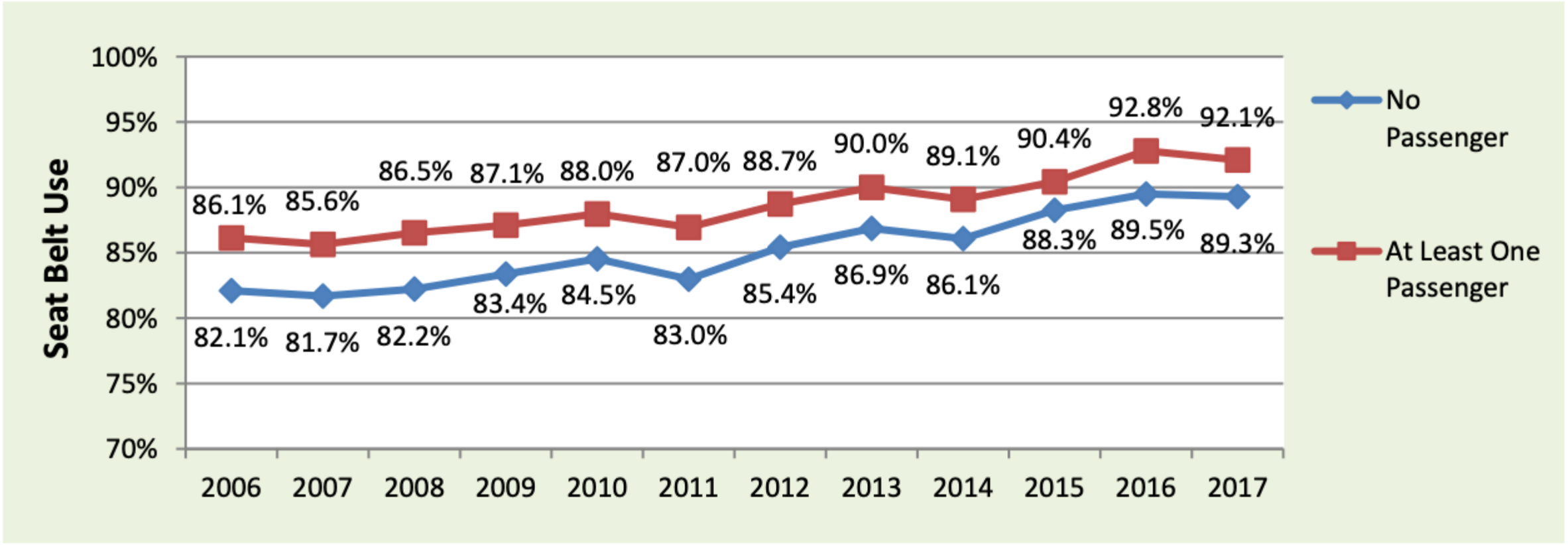
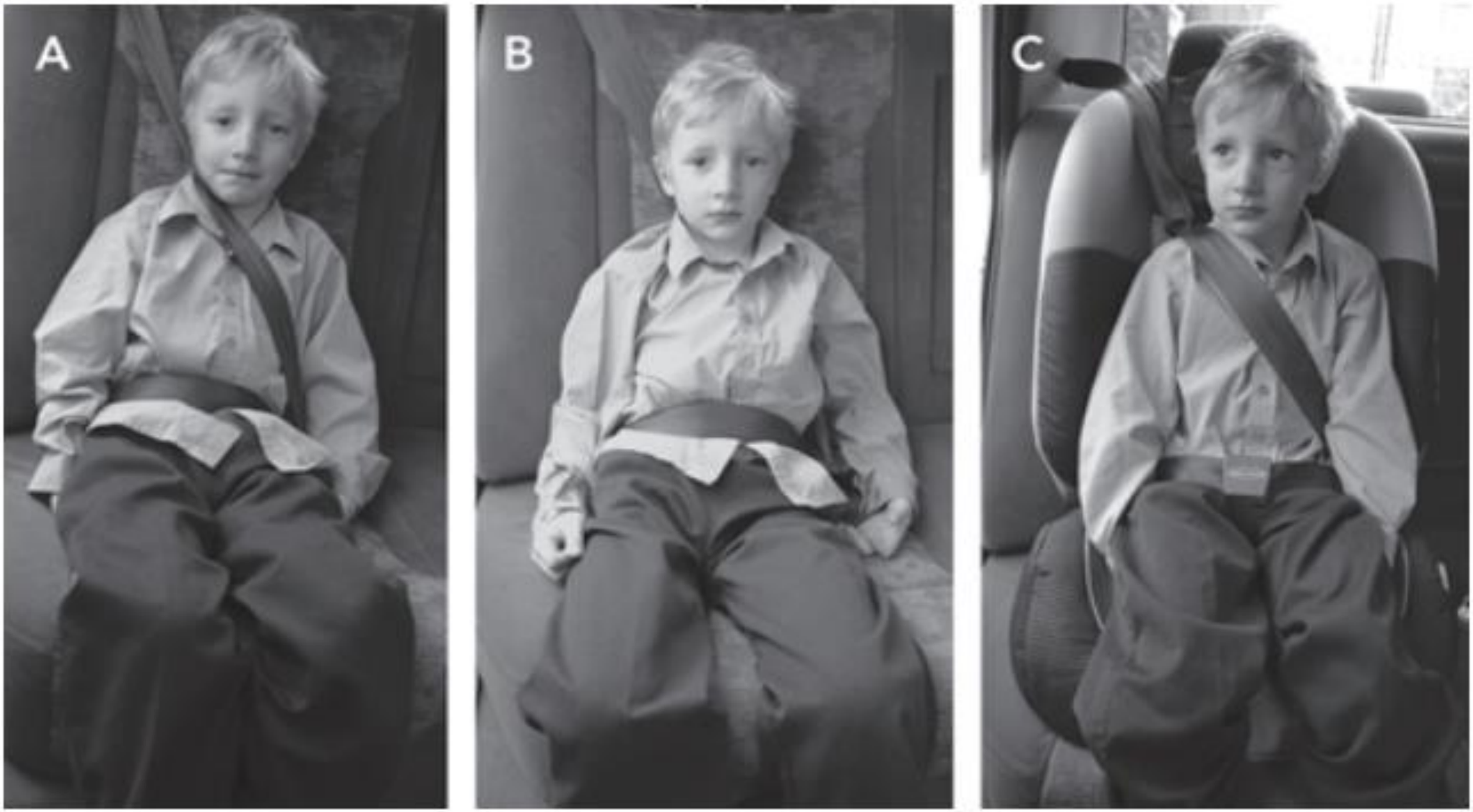
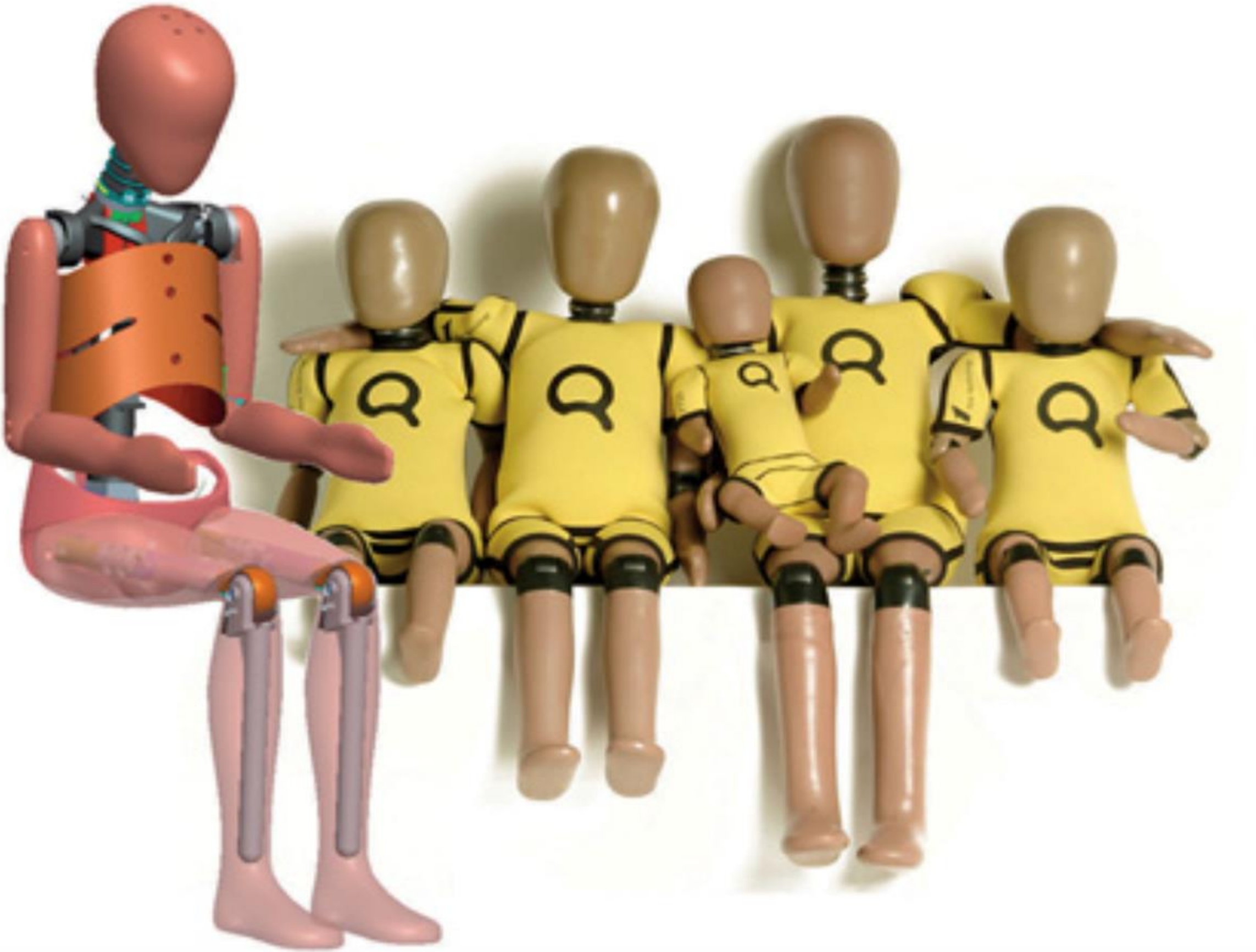


Figure 5: Passenger Effect on Seat Belt Use for Occupants 8 and Older, 2006-2017

1 Uses of an adult seatbelt on a 6-year-old child



A: *Incorrect fit.* ***B:*** *Misuse.* ***C:*** *Improved fit using a booster seat.* ◆



Crash-test dummies such as the Q-child series, made by Humanetics, represent different age-groups

child restraints

3 Child restraint legislation in Australia and other English-speaking countries

Country	Current laws for child restraint use
Australia[31]	• Child restraints mandatory for children up to 1 year of age • Adult seatbelt or child restraint mandatory for children 1–16 years of age
New Zealand[32]	• Child restraints mandatory for children up to 5 years of age • Adult seatbelt or child restraint mandatory for children 5–16 years of age
United Kingdom[33]	• Child restraints mandatory for children up to 12 years of age or height 135 cm • Adult seatbelt mandatory for children > 12 years of age or height > 135 cm
United States[34,35]	• Variation among states: child restraint laws require children to travel in approved child restraint devices, and some permit or require older children to use adult seatbelts. The age at which seatbelts can be used instead of child restraints differs among the states; 38 states have booster seat laws (all have age limits, additionally some have height and weight limits)
Canada[36]	• Variation among provinces: all have child restraint laws, including three with booster seat laws covering children up to 8 years and/or 36 kg and/or 145 cm

◆

infant and child seat belt use 2015-7

As shown in Figure 5, about 7.9 percent of children under age 1 were not in rear-facing car seats in 2017; most of these infants were prematurely transitioned to forward-facing car seats.

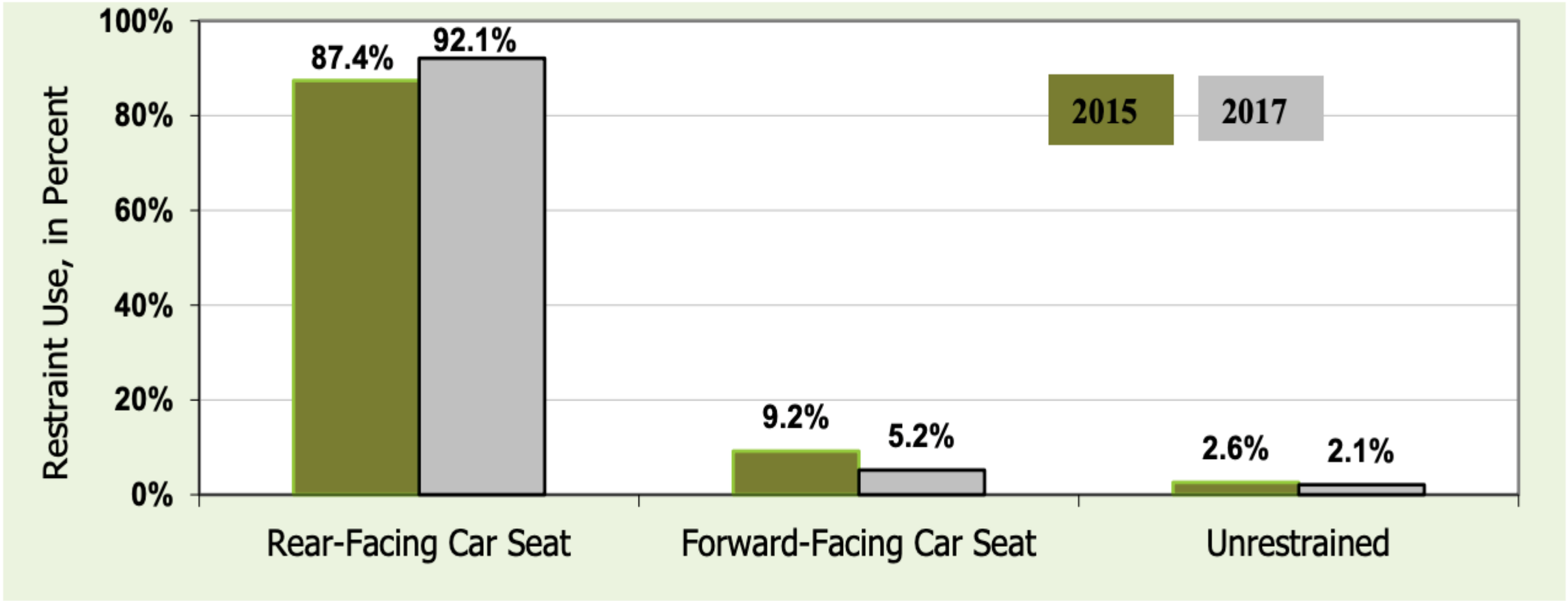


Figure 5: Restraint Use for Children Under Age 1

seat belt use vs age in children and adolescants

Figure 2 displays the trends of seat belt use for the four age groups over a 12-year period (2006-2017). Seat belt use among 16- to 24-year-olds has been consistently lower than other age groups.

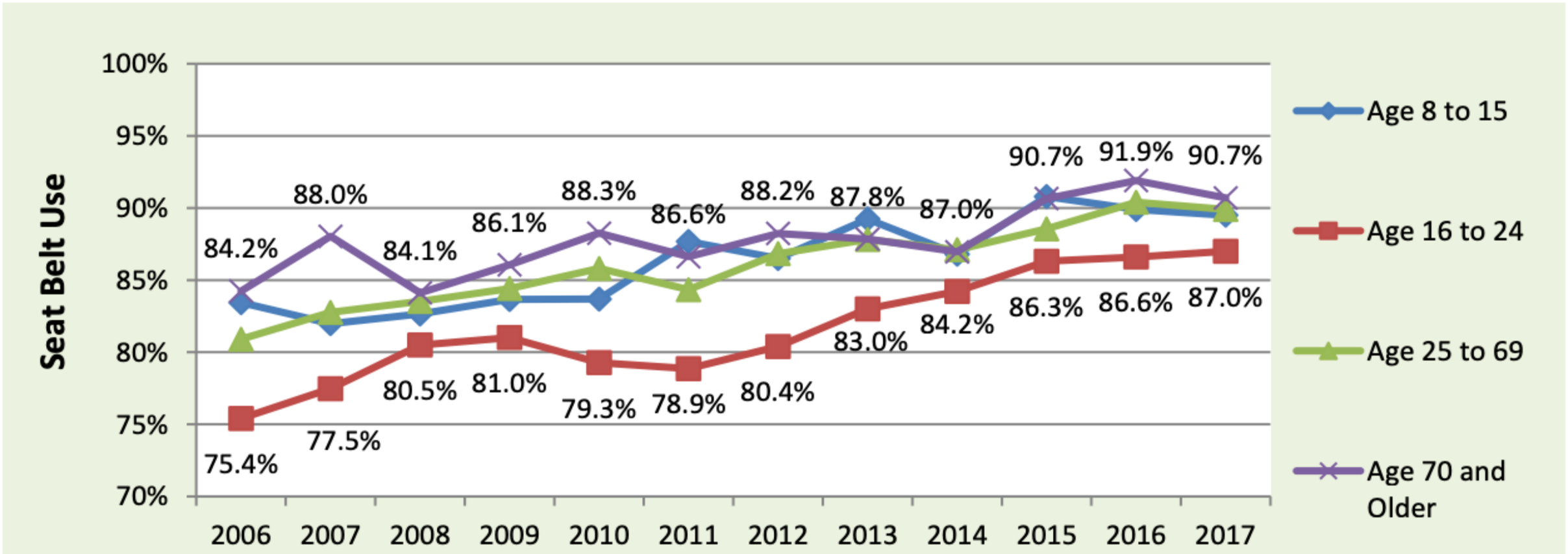


Figure 2: Seat Belt Use by Age for Occupants 8 and Older, 2006-2017

Table 6

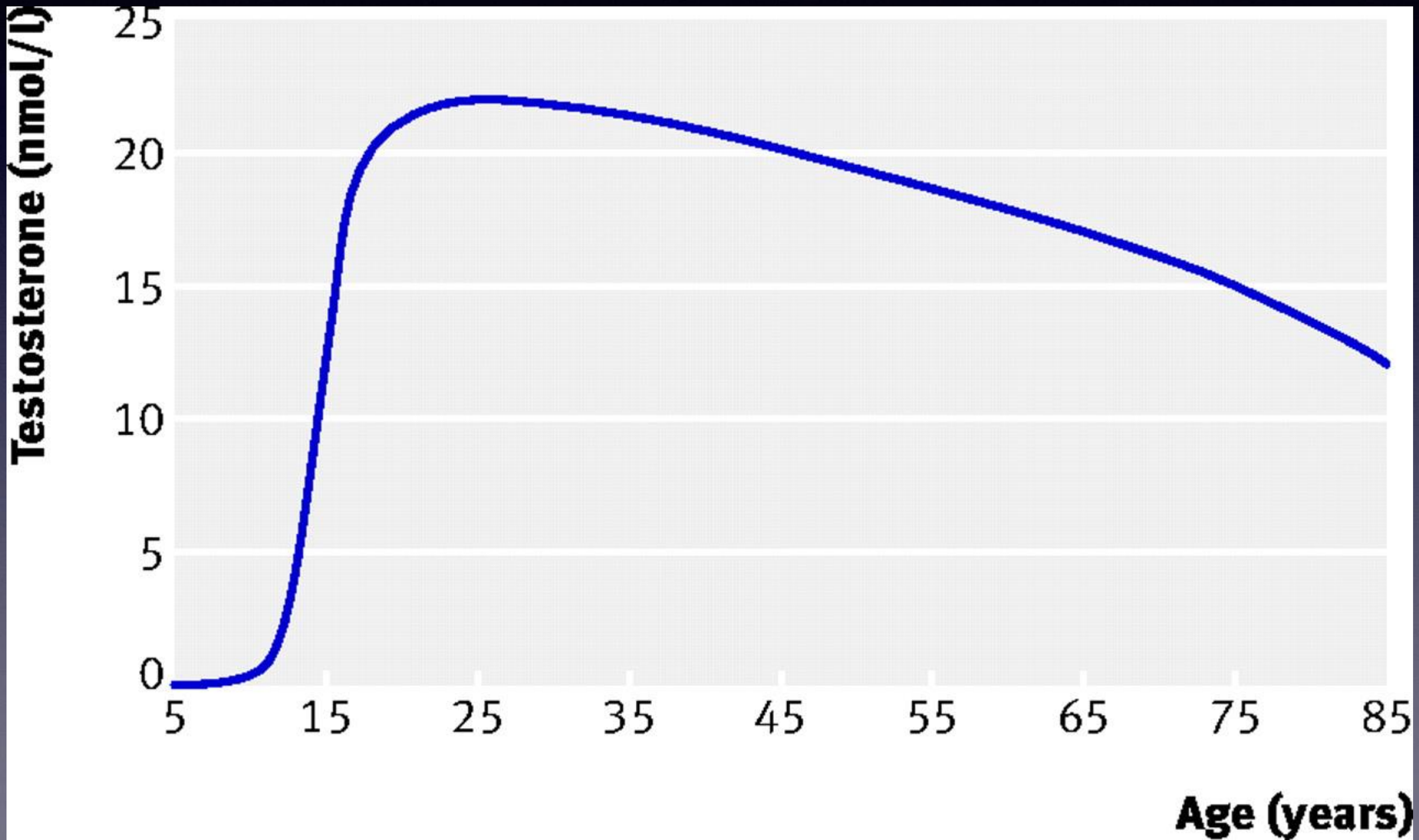
Passenger Vehicle Occupant Fatalities in 2004 by Age Group and Restraint Use

Age Group	Restraint Use				Total	
	Not Used		Used			
	Number	Percent	Number	Percent	Number	Percent
0-7	311	41	440	59	751	100
8-15	683	62	425	38	1,108	100
16-20	3,174	62	1,961	38	5,135	100
21-24	2,373	66	1,222	34	3,595	100
25-34	3,209	64	1,843	36	5,052	100
35-44	2,632	62	1,622	38	4,254	100
45-54	2,093	54	1,752	46	3,845	100
55-64	1,281	48	1,407	52	2,688	100
65 +	1,786	34	3,405	66	5,191	100
Unknown	51	68	23	32	74	100
Total	17,575	55	14,118	45	31,693	100

Source: NCSA, FARS 2004 (ARF)

Unknown restraint use is distributed proportionally to the known use categories.

testosterone vs age



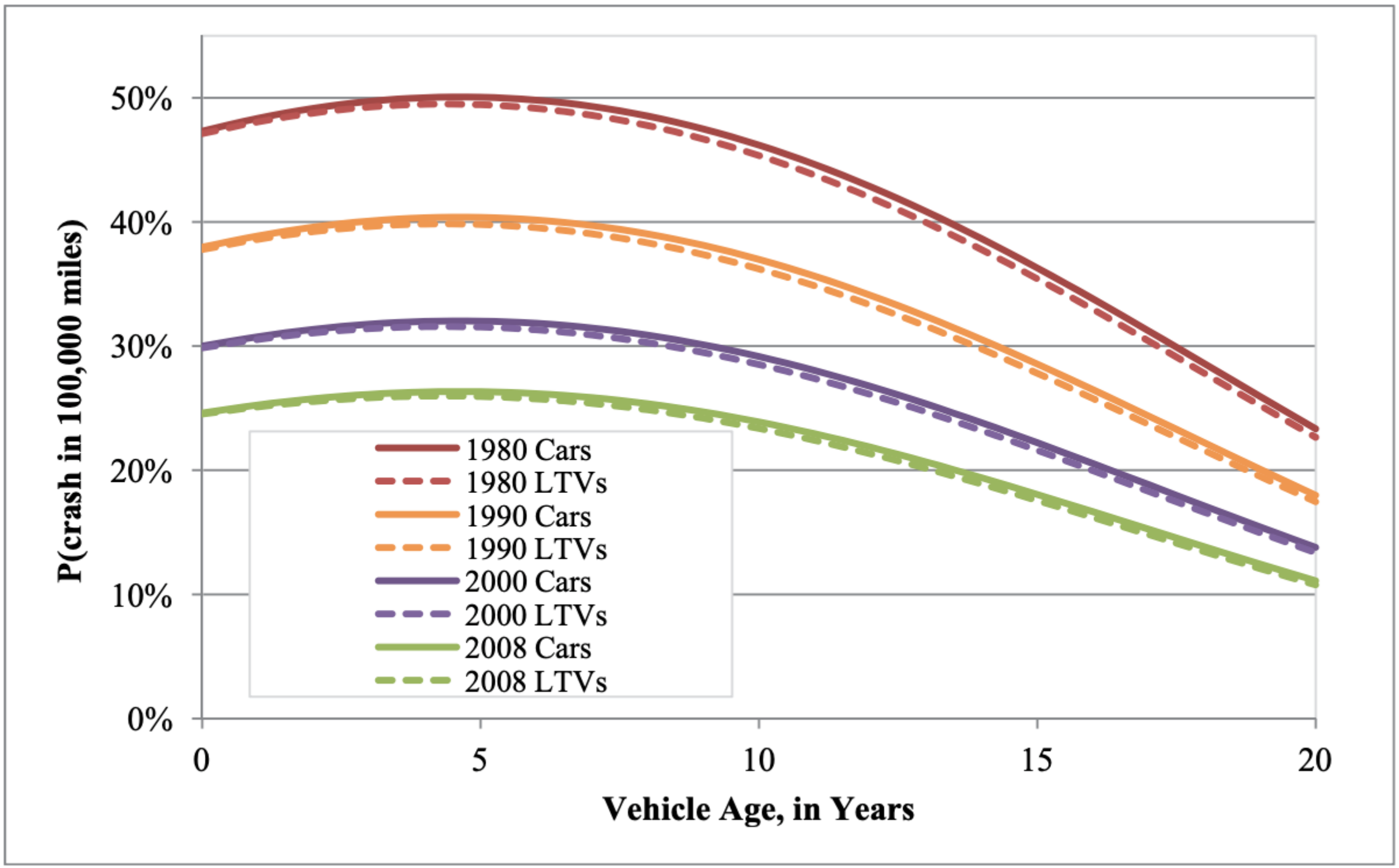


Figure 6-2: Estimated Crash Likelihoods for Cars and LTVs of Various Model Years


2019 VOLVO XC40

Conclusion

Seat belt restraints reduce RTA mortality at least 10%, and morbidity, considerably more.

They have to be applied to the driver and all passengers, of whatever age

Continued persuasion and penalties need to maintain present restraint use

Mobile phone use and Driverless cars pose a new and different challenge

The self-driving Uber SUV that struck pedestrian Elaine Herzberg on March 18, 2018, in Tempe, Ariz.

Feds Say Self-Driving Uber SUV Did Not Recognize Jaywalking Pedestrian In Fatal Crash

November 7, 2019 · 10:57 PM ET

RICHARD GONZALES

Traveling by vehicle has gotten remarkably safer in recent years. Fatality and injury rates reached new lows in 2009, with 1.14 people killed and 75 people injured per 100 million vehicle miles, compared to 1.55 fatalities and 120 injured people 10 years ago (NHTSA's National Center for Statistics and Analysis, 2010).

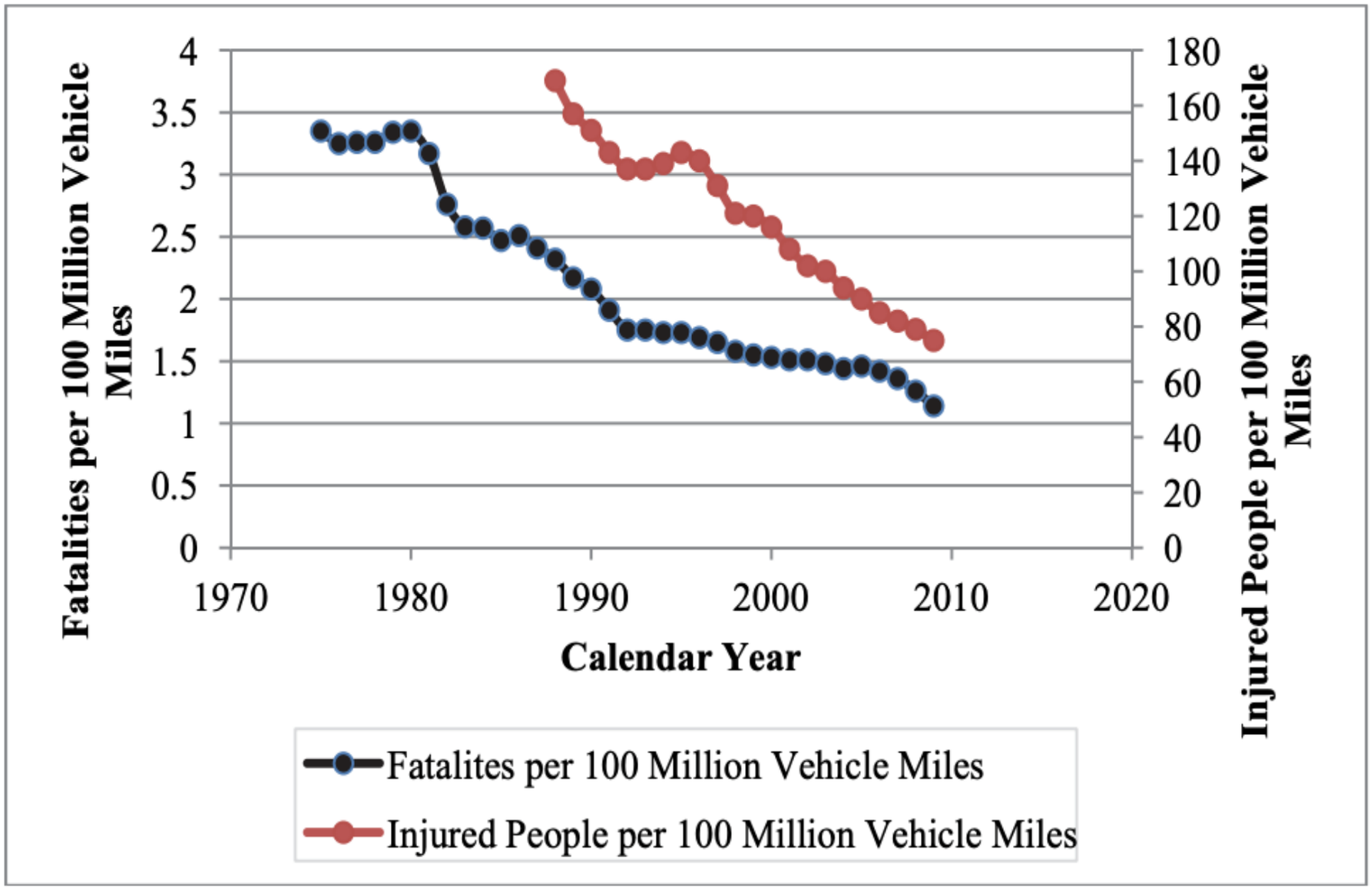


Figure 1-1: Fatalities and People Injured per 100 Million Miles Traveled

Speaking broadly, traffic safety is influenced by three components: human factors, vehicle/equipment factors, and environmental factors, as illustrated in Figure 1-2.

restraint vs fatality

Table 5

Passenger Vehicle Occupant Fatalities in 2004 by Crash Type and Restraint Use

Crash Type	Restraint Use				Total	
	Not Used		Used			
	Number	Percent	Number	Percent	Number	Percent
Single-vehicle Crashes	10,732	69	4,879	31	15,611	100
Mutlivehicle Crashes	6,824	42	9,258	58	16,082	100
Total	17,575	55	14,118	45	31,693	100

Source: NCSA, FARS 2004 (ARF)

Unknown restraint use is distributed proportionally to the known use categories.

TABLE 3. Crash Characteristics for CIREN Case Occupants With CSI

	All Case Occupants (N = 3,524) N	CSI (n = 407) n	CSI (11.5%) %	*p*	OR	95% CI
Seat belt				0.48		
No	1,205	145	12.0		REF	REF
Yes	2,181	245	11.2		0.92	0.74–1.15
Airbag deployed				<0.001		
No	1,149	163	14.2		REF	REF
Yes	2,374	244	10.3		0.69	0.56–0.86
Case vehicle type				0.12		
Automobile	2,457	283	11.5		REF	REF
Light truck	305	35	11.5		1.00	0.69–1.45
Utility vehicle	460	68	14.8		1.33	1.00–1.77
Van-based truck	213	19	8.9		0.75	0.46–1.22
Impact type				<0.001		
Frontal	2,096	199	9.5		REF	REF
Lateral	1,094	129	11.8		1.27	1.01–1.61
Rollover	142	56	39.4		6.21	4.30–8.96
Other	80	16	20.0		2.38	1.35–4.20
Δv (mph)*				0.13		
<30	1,642	154	9.4		REF	REF
30–49	645	64	9.9		1.06	0.78–1.45
≥50	80	13	16.2		1.87	1.01–3.47

REF, reference category.
* Planar crashes only.
Totals in each group may not equal n due to missing data.

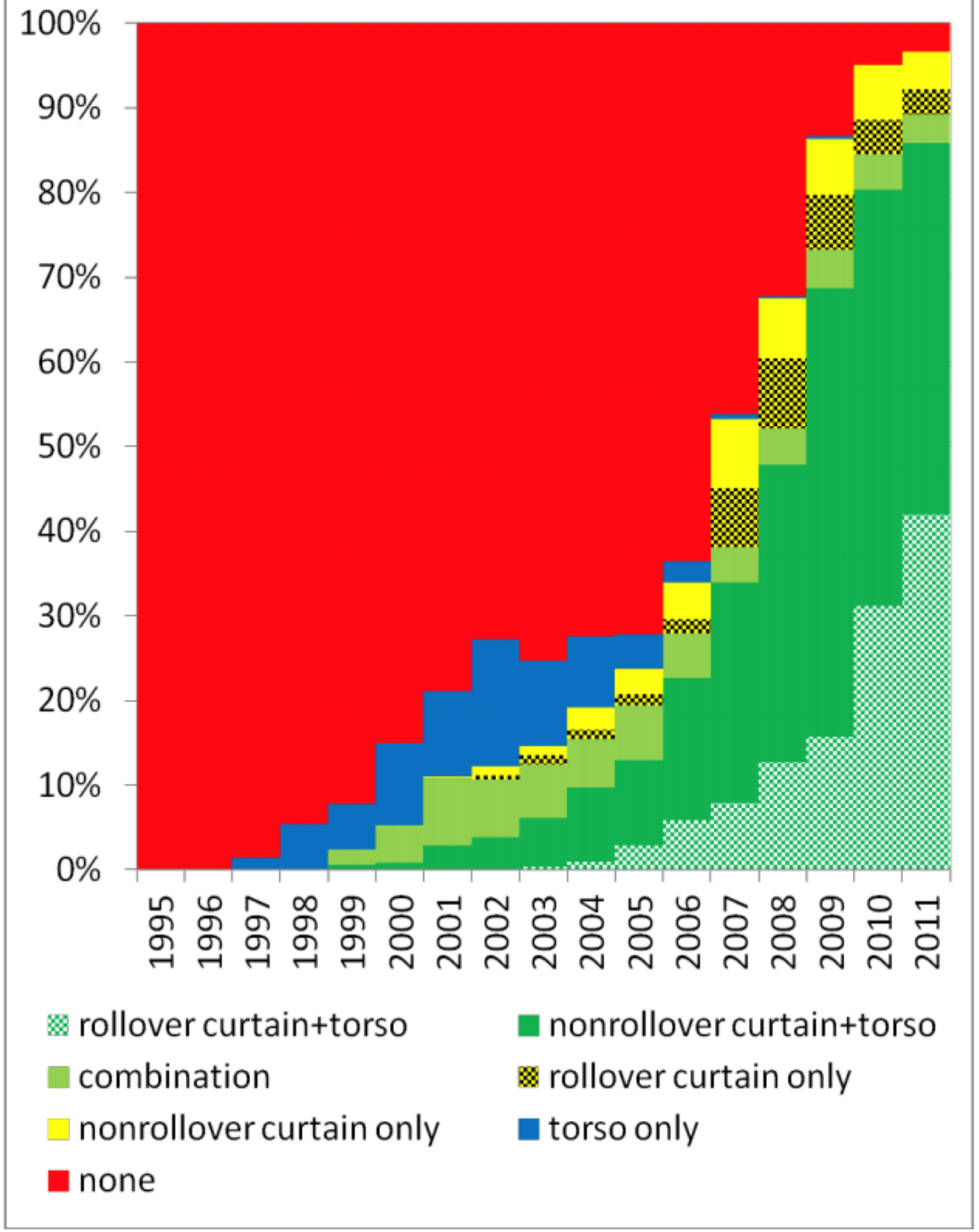
Occupant and Crash Characteristics for Case Occupants With Cervical Spine Injuries Sustained in Motor Vehicle Collisions.

Stein, Deborah; MD, MPH; Kufera, Joseph; Ho, Shiu; Ryb, Gabriel; MD, MPH; Dischinger, Patricia; OConnor, James; MD, MS; Scalea, Thomas

Journal of Trauma-Injury Infection & Critical Care.
70(2):299-309, February 2011.
DOI: 10.1097/TA.0b013e3181f8aa91

TABLE 3. Crash Characteristics for CIREN Case Occupants With CSI

Figure 10: Percentage of Vehicles With Side Air Bags, By Model Year



side impact air bags

Estimated Overall Fatality Reduction (%) in Far-Side Impacts, by Type of Side Air Bags

	Point Estimate	Confidence Bounds	
		Lower	Upper
Curtain + torso	9.7	- .2	18.7
Combination	15.0	5.2	23.7
Curtain only	12.3	- 5.4	27.1
Torso only	- 4.9	- 15.2	4.5
Curtain (with or w/o torso)	10.3	1.1	18.6
Curtain or combination	12.3	5.2	18.9

electronic devices

Driver Use of Electronic Devices, 2006–2017

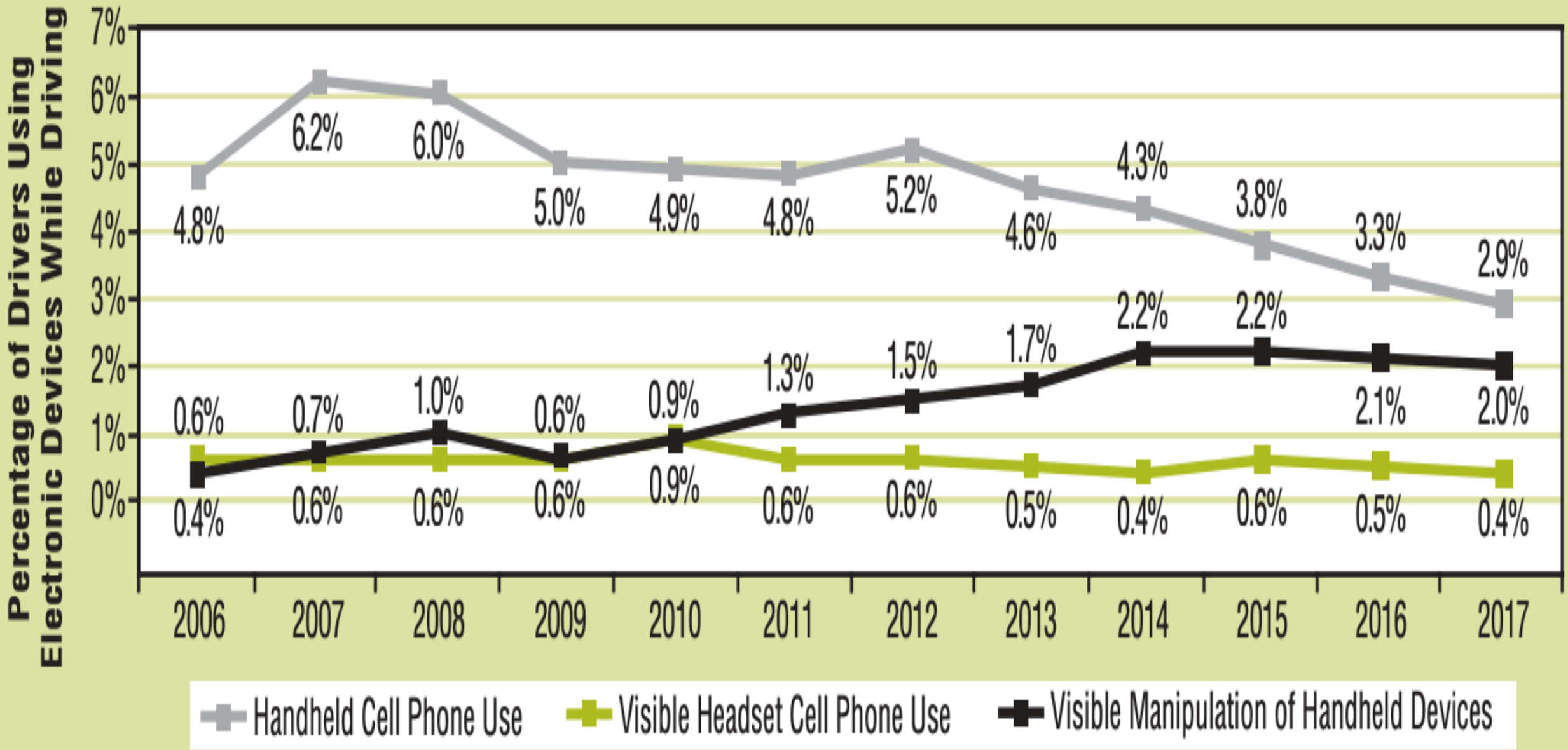


Chart 3: Serious injuries in reported road accidents (adjusted and reported): GB, 2004-2018

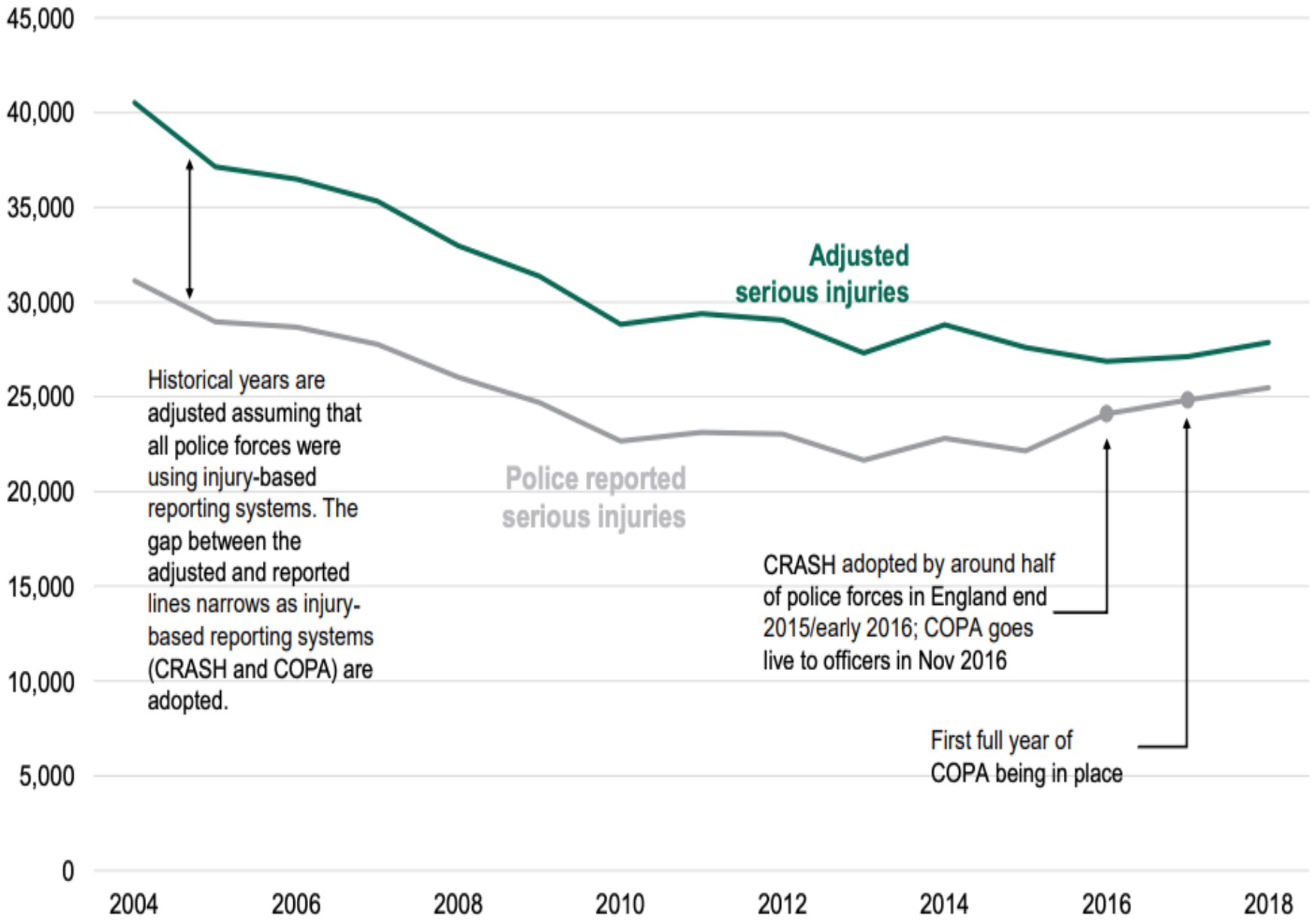
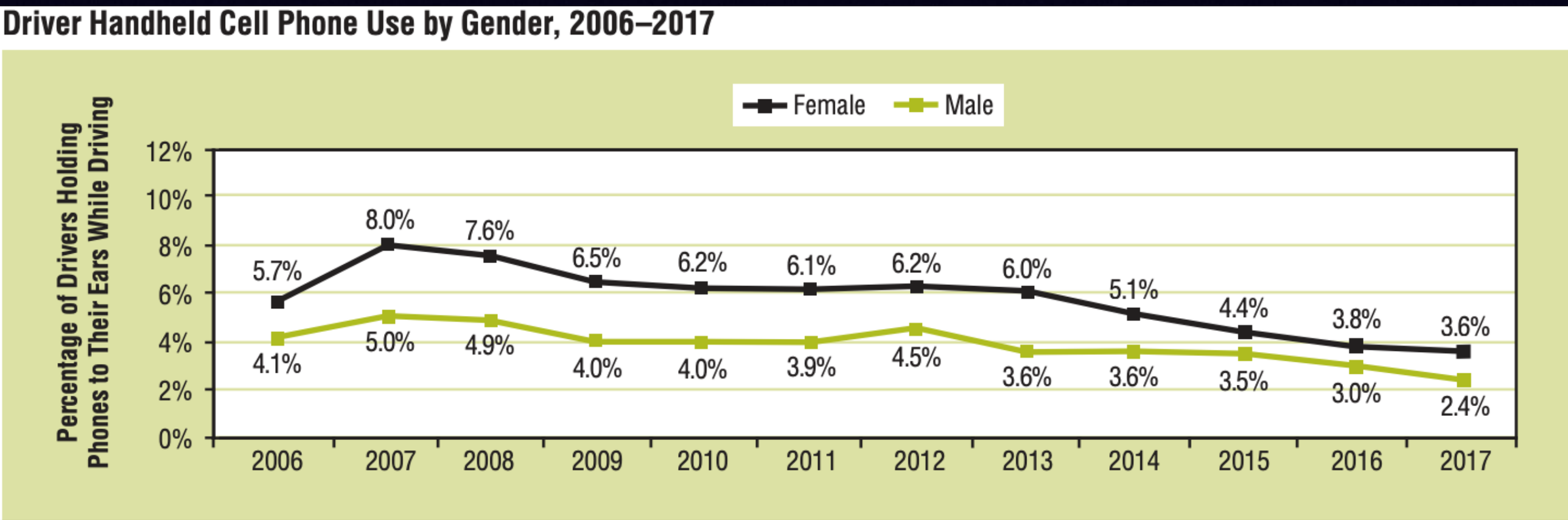


Chart 3 shows that when accounting for changes in reporting, the estimated number of serious injuries in 2016 to 2018 is similar to other years, since 2010, allowing for natural variation in the number of reported road accidents.

Gender vs cell phone use



U.S. Department of Transportation
National Highway Traffic Safety Administration

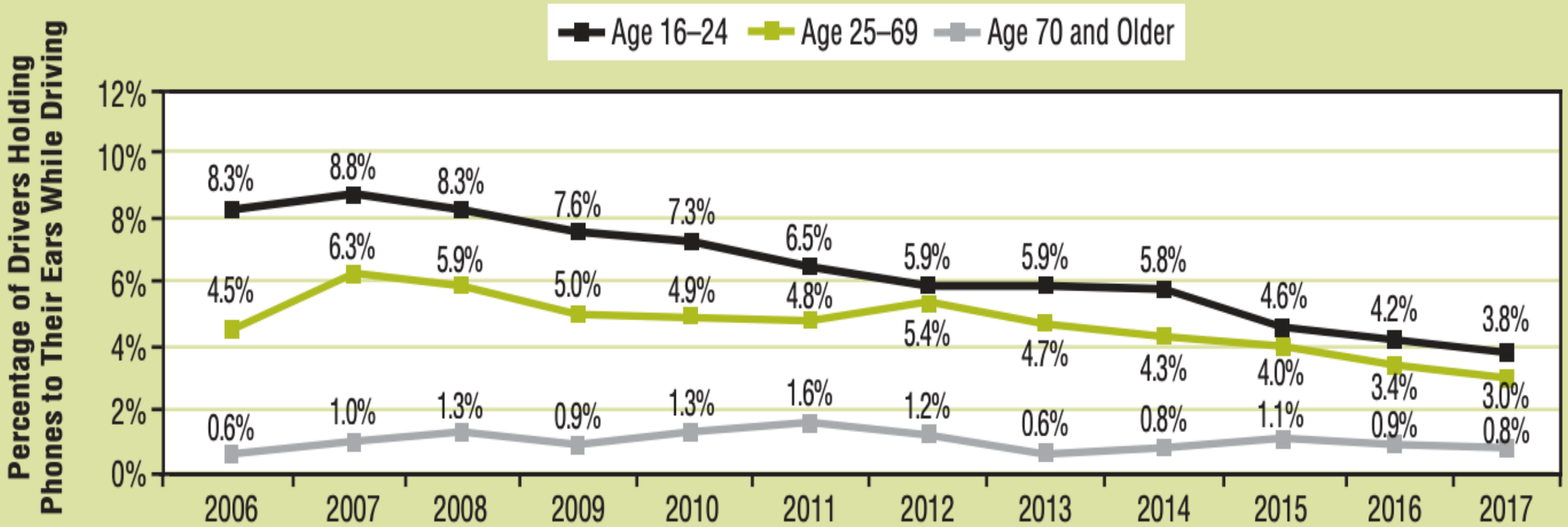
TRAFFIC SAFETY FACTS
Research Note

NHTSA

DOT HS 812 665 | Summary of Statistical Findings | January 2019

Driver Electronic Device Use in 2017

Driver Handheld Cell Phone Use by Age, 2006–2017



Who is to blame for 'self-driving car' deaths?

By Theo Leggett
Business correspondent, BBC News

22 May 2018

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REUTERS

U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

www.nhtsa.gov

DOT HS 811 882

January 2014

Updated Estimates of Fatality Reduction by Curtain and Side Air Bags in Side Impacts and Preliminary Analyses of Rollover Curtains

seat belt use
vs injuries from an RTA

- time line of legislation uk vs world
- evidence of benefit vs harm
- what injuries are prevented and to whom?

Fatalities by road user type

In 2018, **car occupants** accounted for 44% of road deaths, pedestrians 25%, motorcyclists 20% and pedal cyclists 6%.

	Fatalities in 2018	Proportion in 2018	% change since 2017
	777	44%	∨1%
	454	25%	∨3%
	354	20%	∧1%
	99	6%	∨2%
Other	98	5%	∧14%*

II. THE STATISTICAL APPROACH EMPLOYED

A set of econometric models were developed to evaluate the effect of seat belt legislation on driver involved injury rates. The models take the form:

$$Y = \beta_1 + \beta_2 \text{trend} + \sum_{j=3}^{13} \beta_j X_{j-2} + \beta_{14} D + \mu \quad (1)$$

where:

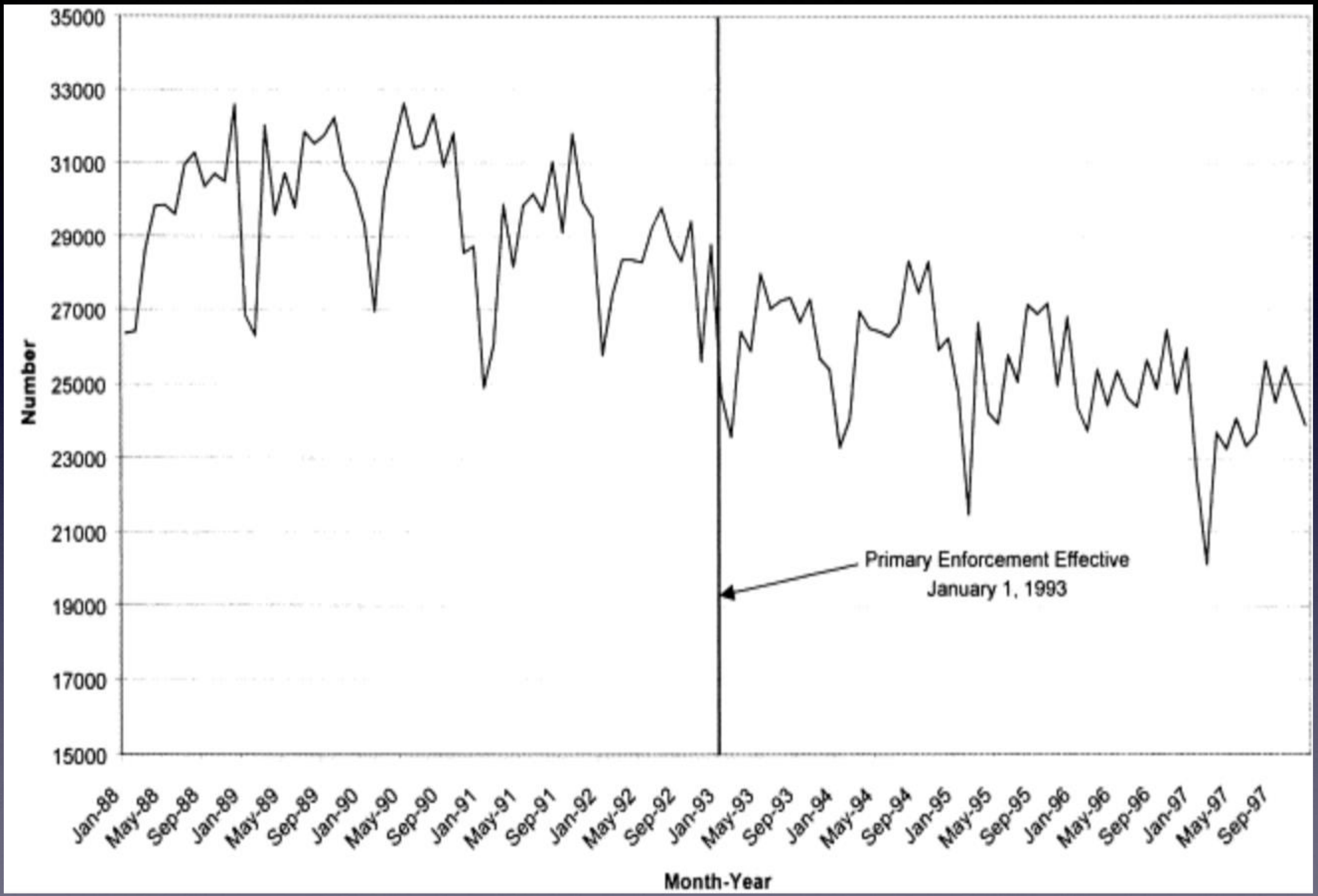
Y = Driver Involved Injury Rate

trend = a time trend

X_{j-2} $(j = 3,4, \ldots ,13)$ = dummy variables to account for seasonality

D = a dummy variable to account for the existence of seat belt regulations

μ = a random error term.


35000
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Primary Enforcement Effective
January 1, 1993
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Month-Year

9. Conclusions

The difference in restraint use in fatal crashes between New England, 53 percent, and the rest of the United States, 58 percent, is not very great and is narrowing.

Restraint use is only one of several variables needed to adequately account for the differences in fatality rates among the States.

Combinations of variables that describe differences in social economic conditions (including safety belt use), congestion, affluence, culture, and land use predict virtually all of the variance of the four fatality rates for the 50 States and the District of Columbia.

The differences in the other variables, beyond the control of vehicle occupants, reduce the expected high fatality rates in New England, if only restraint use is considered.

Restraint use, which appears in all of the "best" models, is the only variable over which motor vehicle occupants have control.

Restraint use is the most effective countermeasure to reduce injuries and fatalities.

US highway dept stats

- In 2004, a majority of the passenger vehicle occupants killed were unrestrained (55%).
- Among the passenger vehicle occupants killed, the unrestrained proportion was higher among males (61%) than females (46%).
- The proportion of unrestrained passenger vehicle occupant fatalities was higher on rural roadways (58%) compared to urban roadways (51%).
- Among vehicle types, unrestrained passenger vehicle occupant fatalities were highest in pickup trucks (69%) followed by SUVs (62%).
- Unrestrained passenger vehicle occupant fatalities were higher in single-vehicle crashes.
- Among all age groups, unrestrained passenger vehicle occupant fatalities were above 60 percent in the 8 to 44 age range.

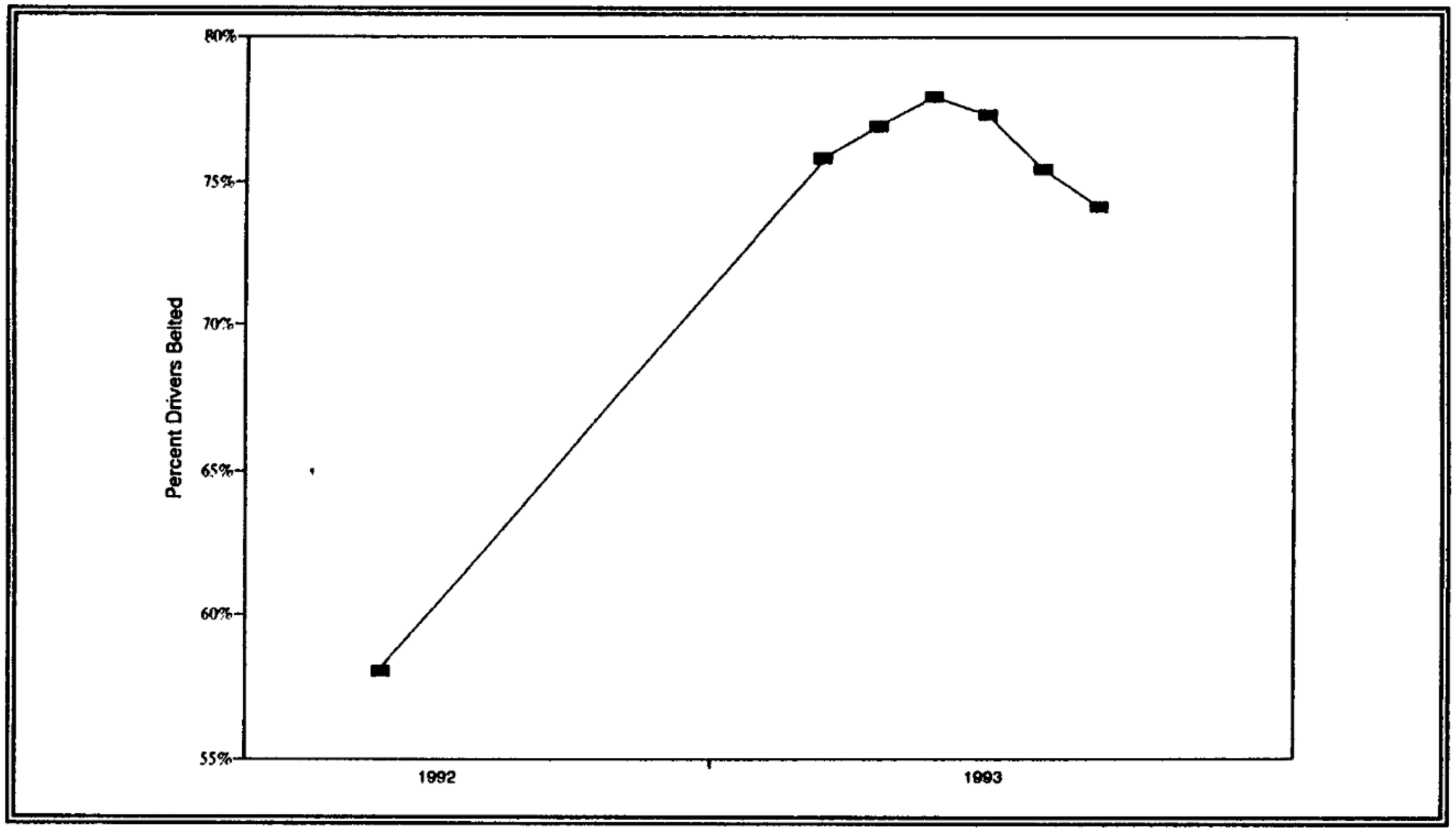

Figure 3. Population Weighted Average Belt Use June 1992, February-July 1993.

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The effectiveness of safety belts in preventing fatalities

Leonard Evans

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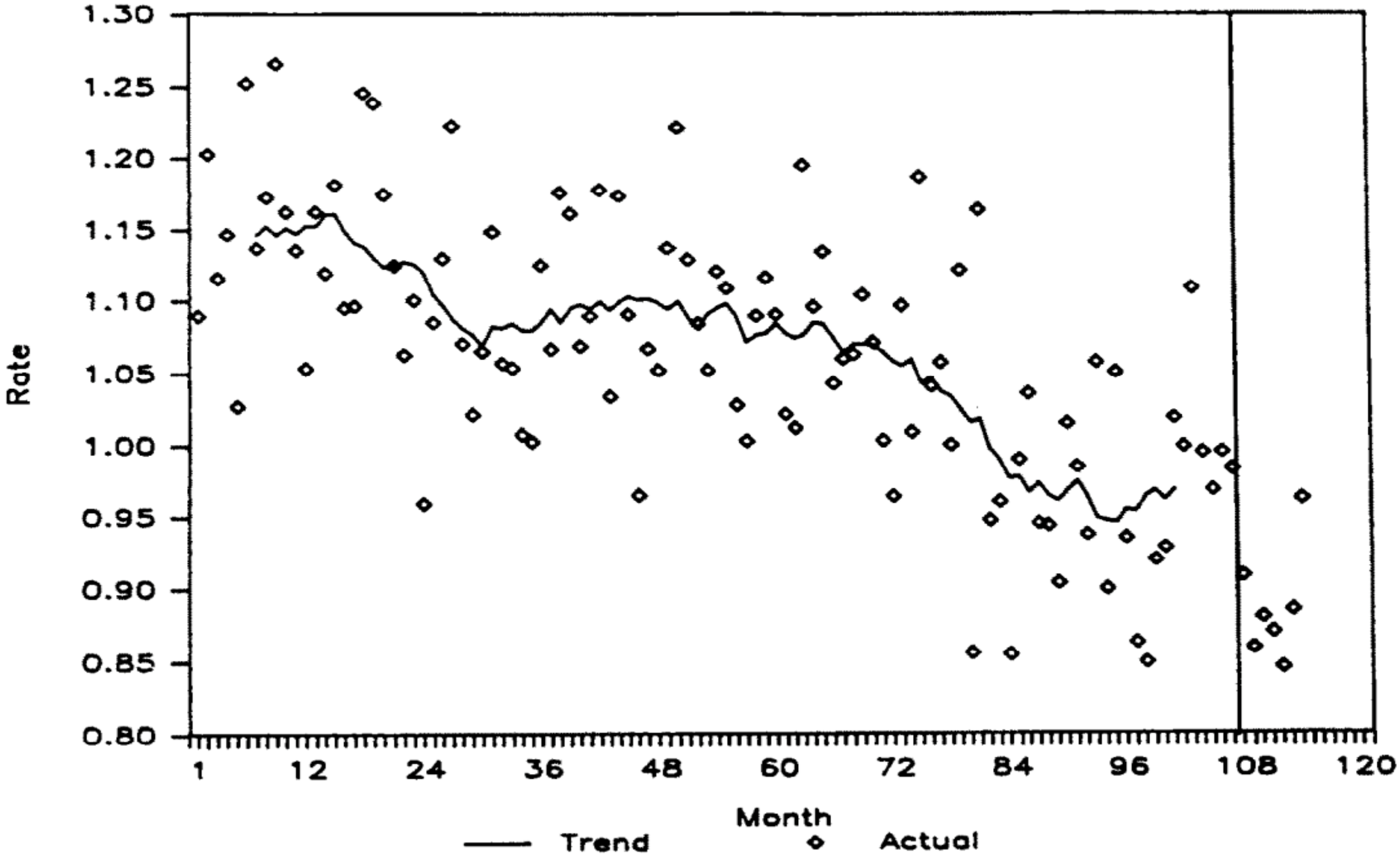
weighted average and standard error of these is (41 ± 4)%. This finding agrees with the 40%–50% range reported in a recent major review and synthesis by the National Highway Traffic Safety Administration. Combining this with the present determination gives (43 ± 3)%; that is, if all presently unbelted drivers and right front passengers were to use the provided three point lap/shoulder belt, but not otherwise change their behavior, fatalities to this group would decline by (43 ± 3)%.

FIGURE 3
AGGREGATE RELATIVE RATE OF FRONT-SEAT FATALITIES
AGE 10 AND OVER PER VMT
FOR EIGHT BELT-LAW VERSUS EIGHT COMPARISON STATES[a]



[a]Time series for each state were aligned on the month in which seat belt use became compulsory (month 108).