UMTRI-2011-9 MARCH 2011

U.S. ROAD FATALITIES PER POPULATION: CHANGES BY AGE FROM 1958 TO 2008

MICHAEL SIVAK
BRANDON SCHOETTLE

UMTRI
UNIVERSITY OF MICHIGAN
TRANSPORTATION RESEARCH INSTITUTE

U.S. ROAD FATALITIES PER POPULATION: CHANGES BY AGE FROM 1958 to 2008

Michael Sivak
Brandon Schoettle

The University of Michigan
Transportation Research Institute
Ann Arbor, Michigan 48109-2150
U.S.A.

Report No. UMTRI-2011-9
March 2011

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTRI-2011-9		

4. Title and Subtitle	5. Report Date
U.S. Road Fatalities per Population: Changes by Age from 1958 to 2008	March 2011
	6. Performing Organization Code 383818
7. Author(s) Michael Sivak and Brandon Schoettle	8. Performing Organization Report No. UMTRI-2011-9
9. Performing Organization Name and Address The University of Michigan Transportation Research Institute 2901 Baxter Road Ann Arbor, Michigan 48109-2150 U.S.A.	10. Work Unit no. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address The University of Michigan Sustainable Worldwide Transportation	13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

The current members of Sustainable Worldwide Transportation include Autoliv Electronics, Bosch, FIA Foundation for the Automobile and Society, General Motors, Honda R&D Americas, Meritor WABCO, Nissan Technical Center North America, Renault, and Toyota Motor Engineering and Manufacturing North America. Information about Sustainable Worldwide Transportation is available at: http://www.umich.edu/~umtriswt

16. Abstract

This report presents a time-series analysis of changes in road safety in the U.S. from the public-health point of view. A 50-year period is examined, from 1958 to 2008. The emphasis is on the changes by decades in fatalities per population across different age groups.

The main findings are as follows. First, from 1958 to 2008, the overall fatality rate per population decreased by 40%. Second, the decrease in the rate was age dependent (with the largest decreases for the youngest and the oldest, and smallest decreases for the middle-aged). Third, the overall fatality rate increased from 1958 to 1968, but it decreased for each of the four following decades. Fourth, the changes in the rate for each decade were age dependent. Fifth, the patterns of these age-dependent changes varied across the decades.

Examples of interventions that are likely to have age-dependent effects consistent with the obtained differential age changes in the fatality rate are discussed. However, other interventions are also likely to have relevant age-dependent effects on the fatality rate.

17. Key Words	18. Distribution Statement
fatalities, rate per population, public health, age	Unlimited

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
None	None	16	

Acknowledgments

This research was supported by Sustainable Worldwide Transportation (http://www.umich.edu/~umtriswt). The current members of this research consortium are Autoliv Electronics, Bosch, FIA Foundation for the Automobile and Society, General Motors, Honda R&D Americas, Meritor WABCO, Nissan Technical Center North America, Renault, and Toyota Motor Engineering and Manufacturing North America.

Contents

Introduction

There is no universal agreement on the proper index of road safety. Traditional indexes include fatalities (or injuries) per distance driven, per vehicle, per driver, per trip, or per population. As argued by Sivak (1996), different measures have different roles and provide different perspectives on the nature of the problem and on potential countermeasures (see Table 1).

Table 1
Roles of different road safety measures. Adapted from Sivak (1996).

Road safety measure	Appropriate role/perspective
Fatality rate per distance driven	Traffic/roadway engineering
Fatality rate per vehicles	Vehicle design and regulation
Fatality rate per driver	Driver education and licensing
Fatality rate per trip	Urban planning
Fatality rate per population	Public health

This report presents a time-series analysis of changes in road safety in the U.S. from the public-health perspective. A 50-year period is examined, from 1958 to 2008. The emphasis is on the changes by decades in fatalities per population across different age groups.

Method

Fatality rates per population were examined for 1958, 1968, 1978, 1988, 1998, and 2008. The age groups considered were under 5, 5-14, 15-24, 25-44, 45-64, 65-74, and 75 and over. Of interest were percentage changes in the fatality rates for each decade. The data came from NSC (2010).

Results

Table 2 presents the fatality rates per population by age groups in 10-year steps from 1958 to 2008. Throughout the period examined, the fatality rates tended to be highest for ages 15-24 and ≥75, and lowest for ≤14.

Table 2
Fatality rates per 100 thousand persons by age group.

Age	Year					
	1958	1968	1978	1988	1998	2008
All	21.3	27.5	23.6	20.1	16.1	12.8
<5	9.1	11.1	9.9	6.7	4.9	2.4
5-14	8.1	10.1	8.6	7.1	4.8	2.5
15-24	37.0	49.8	45.4	37.8	26.9	20.7
25-44	22.3	28.8	24.6	21.2	16.9	14.5
45-64	22.6	27.0	18.2	15.9	14.7	13.2
65-74	33.5	35.1	21.5	19.5	18.5	13.4
≥75	42.3	46.0	28.7	30.2	29.8	19.2

Figure 1 shows the percentage changes in the fatality rates per population by age groups from 1958 to 2008. During these 50 years, the overall fatality rate decreased by 40%. However, there were major differences in the magnitudes of the improvement by age groups. The largest decrease was for those under 5 years of age (74%), while the smallest decrease was for those between 25 and 44 years of age (35%). In general, the decreases were largest for the youngest and the oldest, and smallest for the middle-aged.

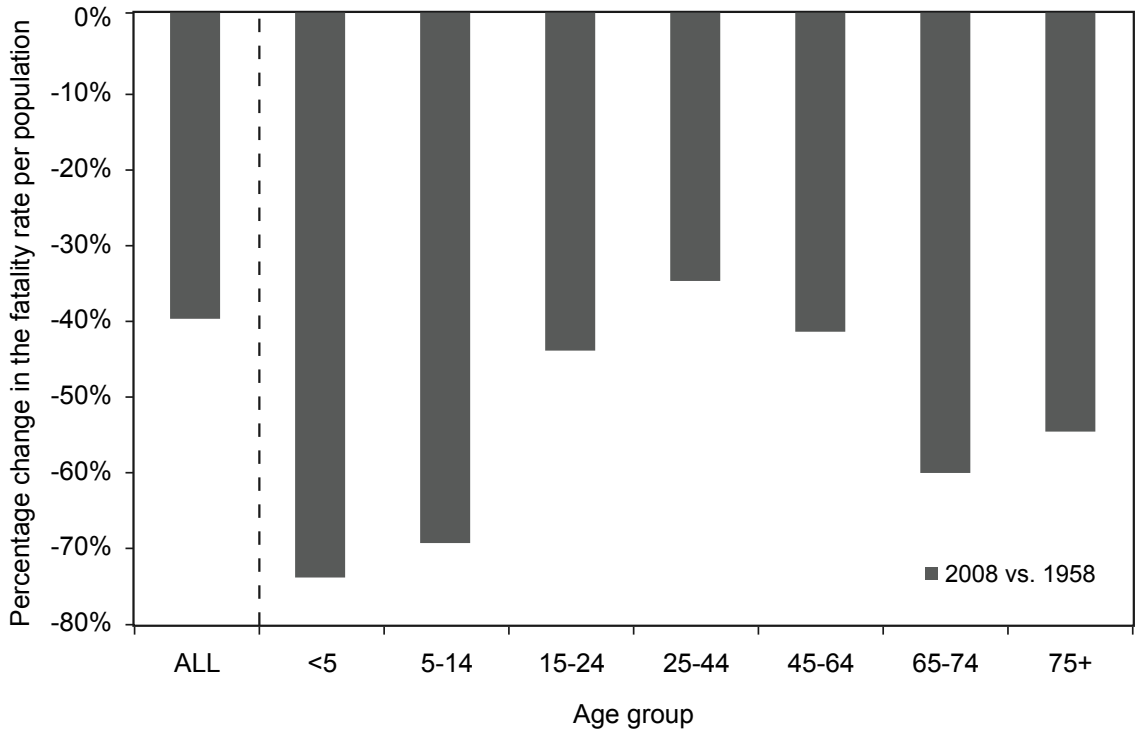

Figure 1. Percentage change in the fatality rates per population by age group from 1958 to 2008.

Figure 2 presents the percentage changes in the fatality rates from 1958 to 1968. Analogous changes for each of the next four decades (1968-1978, 1978-1988, 1988-1998, and 1998-2008) are shown in Figures 3 through 6, respectively. Figure 7 displays the changes for each of the five decades using the same scale.

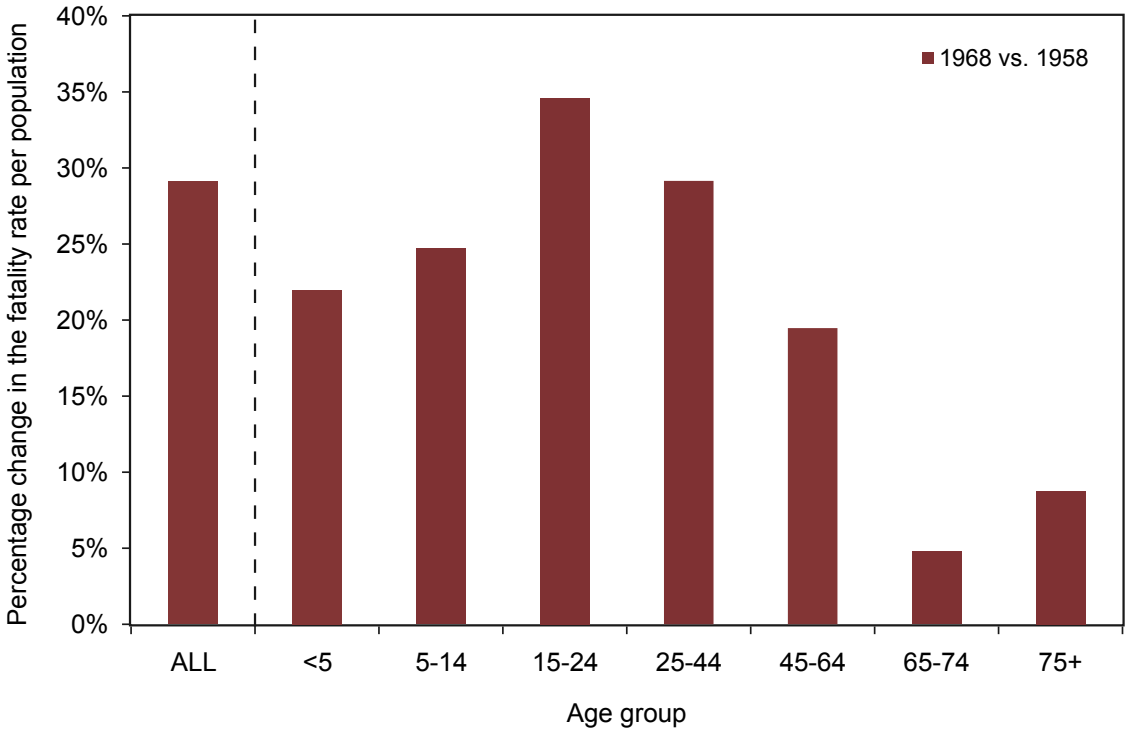

Figure 2. Percentage change in the fatality rates per population by age group from 1958 to 1968.

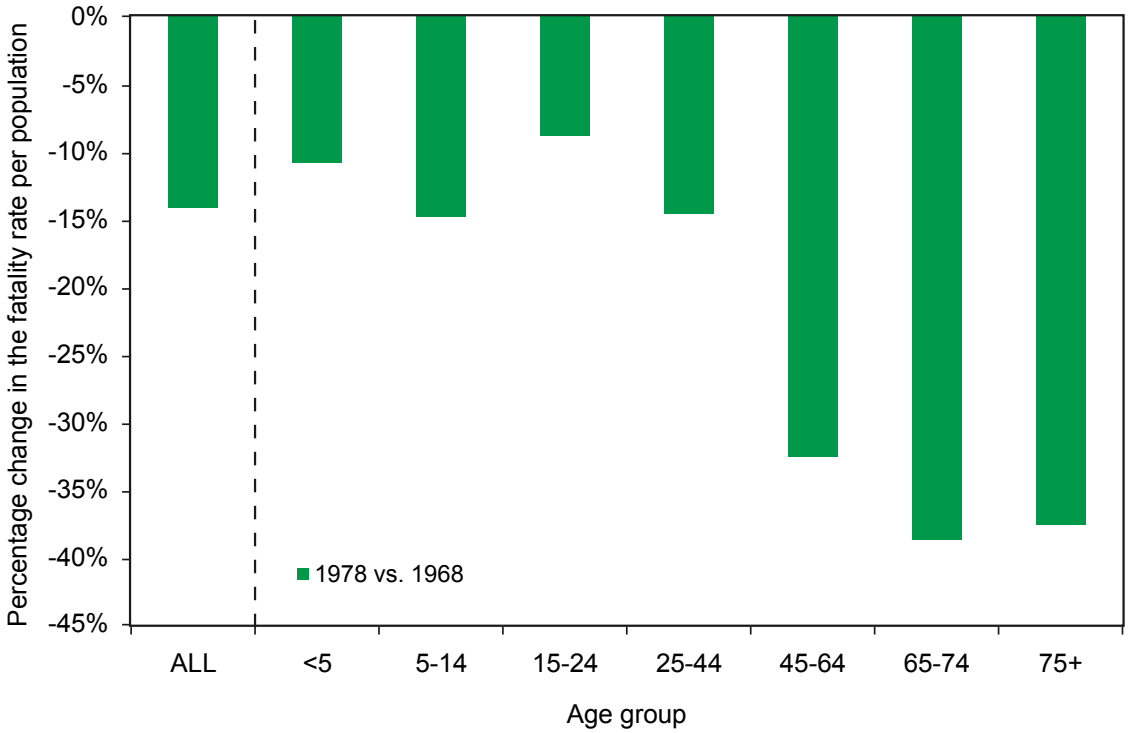

Figure 3. Percentage change in the fatality rates per population by age group from 1968 to 1978.

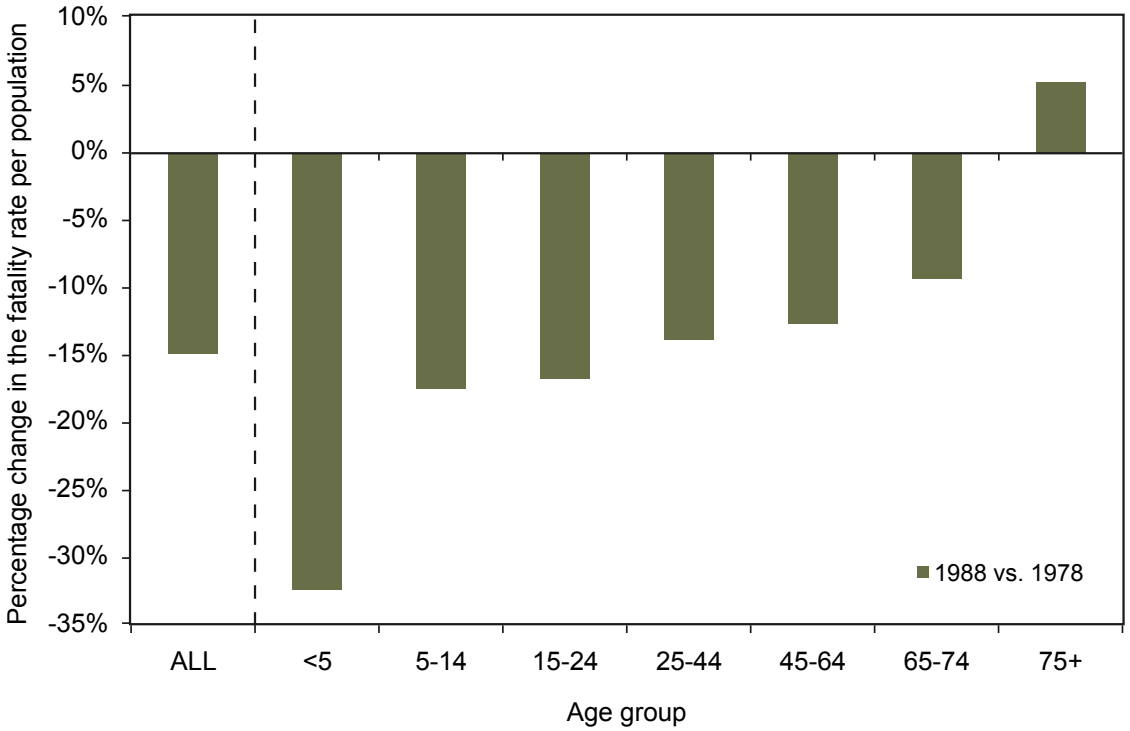

Figure 4. Percentage change in the fatality rates per population by age group from 1978 to 1988.

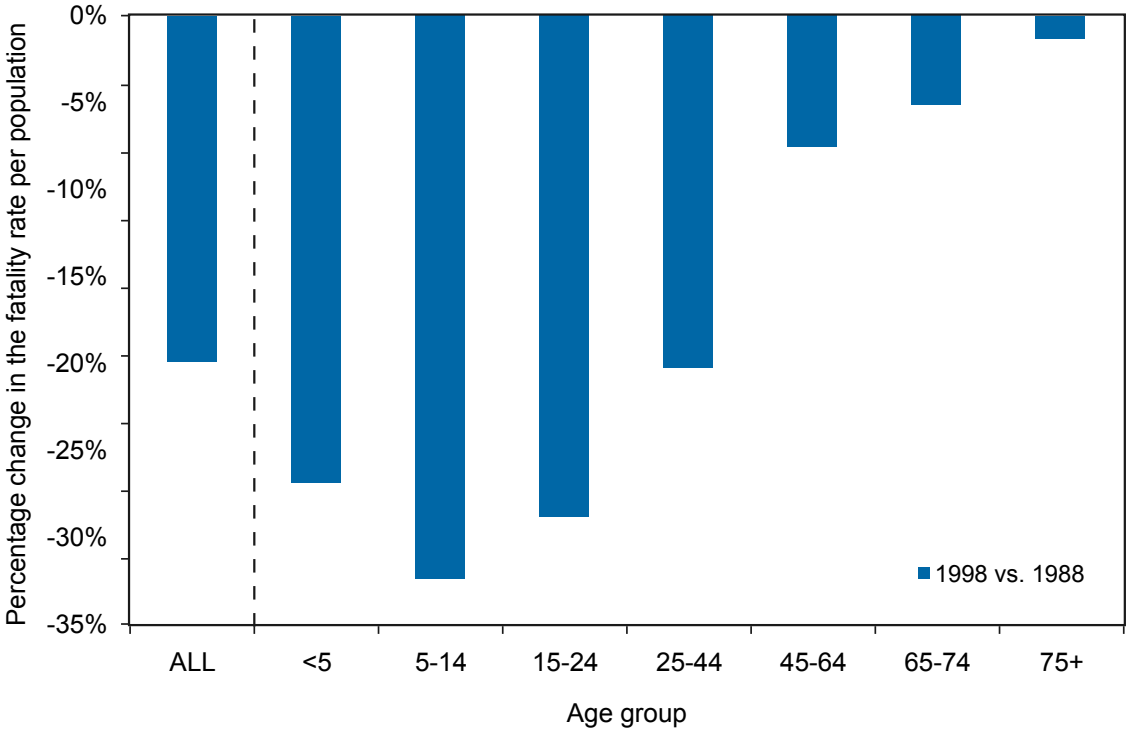

Figure 5. Percentage change in the fatality rates per population by age group from 1988 to 1998.

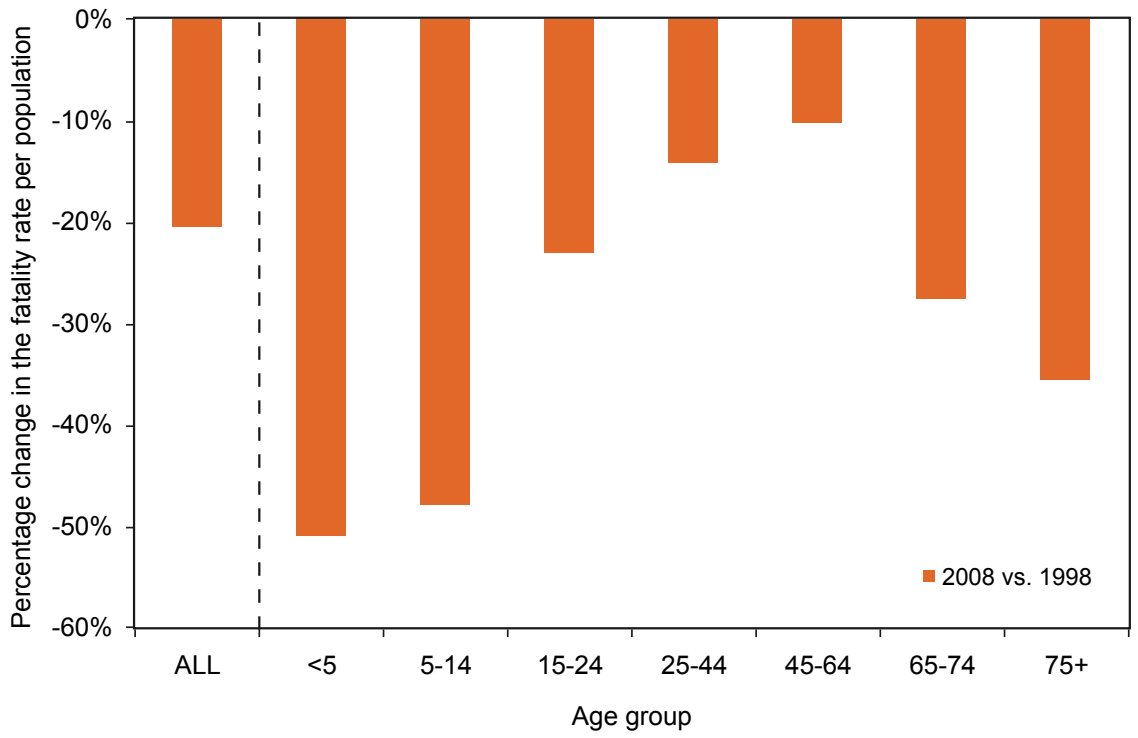

Figure 6. Percentage change in the fatality rates per population by age group from 1998 to 2008.

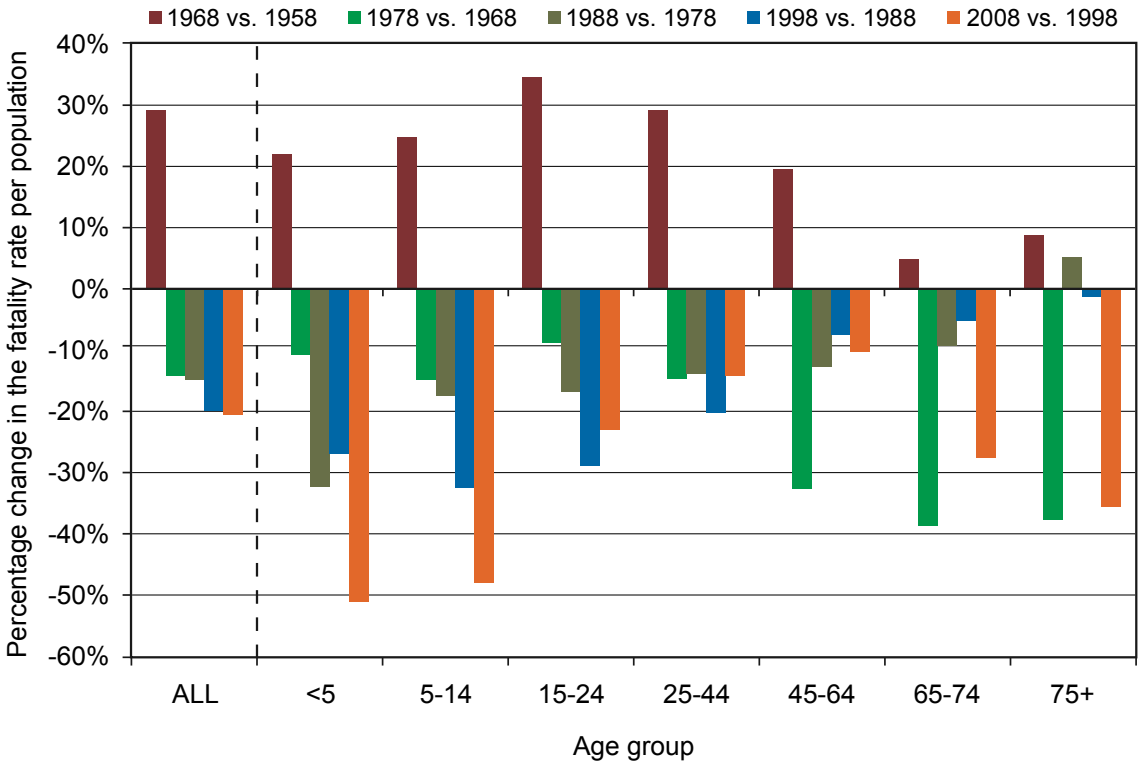

Figure 7. Percentage change in the fatality rates per population by age group and decade from 1958 to 2008.

The main aspects of the data in Figures 2 through 7 are as follows:

(1) The fatality rates per population increased between 1958 and 1968, both overall and for each age group examined. The largest increases occurred for those between 15 and 44, while the smallest increases occurred for those 65 and older.

(2) The fatality rates decreased for each of the four decades between 1968 and 2008. This was the case for both the overall rates as well as for each of the age groups. (There was one exception to this pattern: From 1978 to 1988, the rate for those 75 and older increased slightly.)

(3) The largest decrease in the overall fatality rate was for the last decade examined (1998 to 2008).

(4) The pattern of the decreases in the fatality rates by age groups varied across the decades. The largest decreases in the rates were as follows:

1968 to 1978: 45 and older

1978 to 1988: under 5

1988 to 1998: 24 and younger

1998 to 2008: 14 and younger

Discussion

Overall changes

The fatality rate per population can be conceptualized as a product of the fatality rate per distance driven (how safe is each unit of travel) and the distance driven per population (how much driving is done):

$$\frac{\text{Fatalities}}{\text{Person}} = \frac{\text{Fatalities}}{\text{Distance}} \times \frac{\text{Distance}}{\text{Person}}$$

The values of these three variables for each year (obtained or derived from the information in NSC, 2010) are presented in Table 3.

Table 3
Fatalities per population, fatalities per distance driven, and distance driven per population. (The values in parentheses are percentage changes from 10 years earlier.)

Year	Fatalities per 100 thousand persons	Fatalities per 1 billion miles	Miles driven per person
1958	21.3	55.6	3,831
1968	27.5 *(+29.1%)*	54.0 *(-2.9%)*	5,093 *(+32.9%)*
1978	23.6 *(-14.2%)*	33.9 *(-37.2%)*	6,962 *(+36.7%)*
1988	20.1 *(-14.8%)*	24.2 *(-28.6%)*	8,306 *(+19.3%)*
1998	16.1 *(-19.9%)*	16.5 *(-31.8%)*	9.758 *(+17.5%)*
2008	12.8 *(-20.5%)*	13.3 *(-19.4%)*	9,624 *(-1.4%)*

The data in Table 3 indicates the following main findings:

(1) From 1958 to 1968, the fatality rate per distance driven stayed relatively unchanged. However, because the amount of driving per population increased, so did the fatality rate per population.

(2) For each decade thereafter, there were large reductions in the fatality rate, but these reductions were partially counteracted (except for the latest decade) by the increases in distance driven per population.

(3) As a consequence of (2), the reductions for each decade from 1968 to 1998 in the fatality rate per population were smaller than the reductions in the fatality rate per distance driven.

(4) From 1998 to 2008, there was a slight reduction in the distance driven per population (see also Sivak and Schoettle, 2009). Consequently, the reduction during this decade in the fatality rate per population was slightly more substantial than the reduction in the fatality rate per distance driven.

Age-related changes

General considerations

The most important aspect of the data in Figures 2 through 7 is that the changes in the fatality rate were not the same across all age groups. The differential age changes in the fatality rate could be the consequence of either differential age changes in the amount of driving per person (or in general exposure in the case of passengers, pedestrians, and bicyclists), differential age effects of various road-safety countermeasures, or both. However, because information about the changes in driving and general exposure by age group is not available, we cannot identify the reason(s) for the obtained patterns in the fatality rate.

The following discussion is presented in qualitative terms only and is meant to provide only examples of countermeasures whose effects are likely to be consistent with the obtained patterns of results. The focus of the examples below is on passive-safety countermeasures. However, other possible explanations for the obtained patterns cannot be excluded.

Drivers, passengers, and pedestrians/bicyclists

It is helpful to keep in mind that the fatalities in the first two age groups (<5 and 5-14) are composed mostly of passengers. No drivers are involved. In contrast, the majority of the fatalities in the remaining age groups are drivers. This is the case because (1) the average load per passenger vehicle is currently only about 1.7 (FHWA, 2011), and (2) pedestrians and bicyclists currently account for only 15% of all fatalities (NHTSA, 2011).

1968 vs. 1958

No major safety interventions were introduced in time for the actual fleet on the road to be safer than the fleet in 1958. Consequently, because of the increased amount of driving done per person in 1968 in comparison to 1958, the fatality rate per population also increased from 1958 to 1968. That the largest increases in the fatality rate were for drivers between 15 and 44 years of age is possibly a consequence of this age group increasing the amount of driving more so than those 45 and older.

1978 vs. 1968

Installation of front safety belts and energy-absorbing steering columns were required starting in 1968. Given the frailty of older persons, these countermeasures were likely to have a larger impact on older rather than younger vehicle occupants. This is a possible explanation for the fact that from 1968 to 1978, the largest drop in the fatality rate was for the oldest three age groups.

1988 vs. 1978

The first law requiring child restraint use was introduced in 1977 (in Tennessee), and most states followed by 1985. Consequently, it is not surprising that the largest reduction in the fatality rate from 1978 to 1988 was for those under 5 years of age.

1998 vs. 1988

Airbags for frontal impact began to be widely introduced in 1989 after the government mandated automatic passive restraint systems. Given that the original airbags were designed to protect primarily unbelted occupants, and younger occupants were less likely to wear safety belts than older occupants, the benefits of the airbags (in terms of a reduction in the fatality rate) were possibly more pronounced in the younger age groups.

2008 vs. 1998

Starting around 1995, there was an increase in the quality and use of child restraints and boosters, likely contributing to the fact that the largest reductions between 1998 and 2008 in the fatality rates were for those under 15. Furthermore, side airbags were more frequently installed during this period, coupled with vehicle improvements in side-impact performance (after the introduction of dynamic side-impact requirements in 1990). These later improvements have likely benefitted older drivers and passengers the most. These mechanisms could account for the fact that, during this decade, the youngest and oldest experienced the greatest benefits.

Caveat

As indicated above, the outlined passive-safety interventions are presented only as examples of interventions whose age-dependent effects are qualitatively consistent with the obtained age-related patterns of changes on the fatality rate. Other passive safety interventions, as well as interventions in the active-safety domain (e.g., ABS and ESC systems, and improvements in headlighting) and in the policy domain (e.g., safety-belt laws, graduated licensing, minimum drinking age, and alcohol-tolerance limits) are all likely to have differential age effects. Consequently, no claim is being made that the obtained patterns of age-related changes in the fatality rate are, indeed, a consequence of the specific interventions discussed.

Conclusions

This report presented a time-series analysis of changes in road safety in the U.S. from the public-health point of view. A 50-year period was examined, from 1958 to 2008. The emphasis was on the changes by decades in fatalities per population across different age groups.

The main findings are as follows. First, from 1958 to 2008, the overall fatality rate per population decreased by 40%. Second, the decrease in the rate was age dependent (with the largest decreases for the youngest and the oldest, and smallest decreases for the middle-aged). Third, the overall fatality rate increased from 1958 to 1968, but it decreased for each of the four following decades. Fourth, the changes in the rate for each decade were age dependent. Fifth, the patterns of these age-dependent changes varied across the decades.

Examples of interventions that are likely to have age-dependent effects consistent with the obtained differential age changes in the fatality rate were presented. However, other interventions are also likely to have relevant age-dependent effects on the fatality rate.

References

FHWA [Federal Highway Administration]. (2011). *National Household Travel Survey* (http://nhts.ornl.gov). Accessed February 3, 2011.

NHTSA (National Highway Traffic Safety Administration). (2011). *Fatality Analysis Reporting System* (http://www-fars.nhtsa.dot.gov). Accessed January 30, 2011.

NSC [National Safety Council]. (2010). *Injury facts* (2010 edition). Itasca, IL: Author.

Sivak, M. (1996). Motor vehicle safety in Europe and the USA: A public-health perspective. *Journal of Safety Research*, *27*, 225-231.

Sivak, M. and Schoettle, B. (2009). *Recent reductions in carbon dioxide emissions from new vehicles* (Report No. UMTRI-2009-28). Ann Arbor: The University of Michigan Transportation Research Institute.