

Projecting Fatalities in Crashes Involving Older Drivers, 2000–2025

Patricia S. Hu*
Donald W. Jones*
Timothy Reuscher**
Richard S. Schmoyer, Jr.*
Lorena F. Truett*

*Oak Ridge National Laboratory
Oak Ridge, Tennessee

**Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee

October 2000

This research was funded by
GM pursuant to an agreement between
GM and the U.S. Department of Transportation
under CRADA No. ORNL98-0500

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
managed by
UT-BATTELLE, LLC
for the
U. S. DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

TABLE OF CONTENTS

LIST OF FIGURES	vii
LIST OF TABLES	viii
ACRONYMS LIST	xi
EXECUTIVE SUMMARY	ES-1
1. INTRODUCTION	1-1
2. RESEARCH METHODOLOGY	2-1
3. OVERVIEW OF THE LITERATURE	3-1
3.1 THE ELDERLY POPULATION IN THE UNITED STATES	3-1
3.1.1 By Age Groups and Cohorts	3-2
3.1.2 By Gender	3-3
3.1.3 By Economic Status	3-4
3.1.4 By Race, Ethnicity, and Social Characteristics	3-6
3.1.5 By Geographic Distribution	3-7
3.2 HEALTH ISSUES	3-10
3.2.1 Impacts of Failing Health on Driving Abilities	3-11
3.2.2 Impacts of Increasing Frailty on Casualty Rates	3-14
3.2.3 Health and Education Levels	3-14
3.2.4 Assessment Tools and Retraining	3-15
3.2.5 Better Health, Extended Life Spans, Later Retirement, and Greater Mobility	3-16
3.3 TRANSPORTATION AND MOBILITY	3-17
3.3.1 Numbers of Drivers	3-17
3.3.2 Changes in Driving Habits	3-20
3.3.3 Driving Distances	3-21
3.3.4 Alternative Transportation Modes	3-22
3.3.5 “Intelligent” Technologies and Other Adaptive Equipment	3-23
3.4 CRASH LITERATURE	3-26
3.4.1 Crash Involvement	3-27
3.4.2 Other GM Project Results (Projects G.1 and G.8)	3-28
3.4.3 Gender Effects	3-30
3.4.4 Crashes Involving Elderly Drivers	3-32
3.4.5 Projections of Crashes and Casualties	3-34

4.	ANALYSIS OF DATA SETS	4-1
4.1	INTRODUCTION	4-1
4.2	ASSESSMENT OF DATA SOURCES	4-2
4.2.1	Population Data and Projections	4-2
4.2.2	Income Data	4-2
4.2.3	Drivers and Driving Distance Information	4-4
4.2.4	Physical/Functional Limitations	4-5
4.2.5	Crashes, Casualties, and Fatalities	4-7
4.2.6	Other Data Categories Considered	4-9
4.3	CONCLUSIONS	4-9
5.	OVERVIEW OF THE MODELING SYSTEM	5-1
5.1	INTRODUCTION TO MODELING	5-1
5.2	BRIEF EXPLANATION OF DEMAND THEORY	5-2
5.3	POPULATION PROJECTIONS	5-3
5.4	HEALTH STATUS DATA	5-6
5.5	ASSUMPTIONS	5-8
6.	THE PROPORTION OF THE ELDERLY POPULATION THAT DRIVES ..	6-1
6.1	HISTORICAL TRENDS IN ELDERLY DRIVING	6-1
6.2	MODELING THE DECISION TO DRIVE	6-2
6.3	PROJECTING THE PROPORTION OF OLDER POPULATIONS THAT WILL DRIVE	6-7
7.	VEHICLE MILES TRAVELED	7-1
7.1	HISTORICAL TRENDS IN ELDERLY DRIVING	7-1
7.2	EMPIRICAL MODELING OF VMT	7-3
7.3	PROJECTING VMT	7-9
8.	FATAL CRASH RATES	8-1
8.1	MODELING FATALITY RATES FOR OLDER DRIVERS	8-1
8.2	FATAL CRASH RATE PROJECTIONS	8-10
8.3	DRIVER FATALITY PROJECTIONS	8-16
9.	ANALYSIS OF THE FATALITY PROJECTIONS	9-1
9.1	CONTRIBUTIONS OF INDIVIDUAL COMPONENTS TO DRIVER FATALITY PROJECTIONS	9-1
9.1.1	Computations	9-2
9.1.2	Contributions to Driver Fatalities	9-3
9.2	SENSITIVITY ANALYSIS	9-4
9.2.1	Total Impacts on Older Driver Fatalities	9-7
9.2.2	Sensitivity of the Projection Components to Individual Variables ..	9-9

9.3	A LOWER BOUND FOR DRIVER FATALITIES AND VMT	9-9
9.3.1	The Effect of Time on VMT Projections	9-14
9.3.2	Driver Fatalities with Lower Bounded VMT	9-16
9.4	USER INTERFACE FOR “WHAT-IF” ANALYSIS	9-18
9.4.1	Customized Projections Wizard	9-19
10.	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	10-1
10.1	SUMMARY OF FINDINGS	10-1
10.1.1	Aggregate Fatality Projections	10-1
10.1.2	Comparison of ORNL Aggregate Fatality Projections to Other Studies	10-2
10.1.3	Disaggregated Projection Results	10-8
10.2	CONCLUSIONS	10-10
10.3	DIRECTIONS FOR FUTURE RESEARCH	10-12
10.3.1	The Role of Infrastructure and Equipment	10-12
10.3.2	Asymptotic Projection of VMT	10-12
10.3.3	Additional and Improved Measures of Health Status	10-13
10.3.4	Comparison of Younger and Older Drivers’ Behavior	10-14
10.3.5	Alternate Transportation Options for the Elderly	10-14
	REFERENCES	R-1
	GLOSSARY	G-1
	APPENDIX A. Endogenous Variable Projections	A-1
	APPENDIX B. Exogenous Variable Projections	B-1
	APPENDIX C. Notes	C-1

LIST OF FIGURES

Figure ES-1	Projected Active Drivers as a Percentage of the Population	ES-4
Figure ES-2	Projected Vehicle Miles of Travel per Person	ES-4
Figure ES-3	Driver Risk (deaths per 100 million miles)	ES-5
Figure 1.1	U.S. Elderly Population Estimates, by Age and Year	1-1
Figure 1.2	United States Projected Population Increase, 1995 to 2020	1-4
Figure 3.1	Distribution of the Elderly Population in the Northeast Region by Gender and Age Group between 1995 and 2020	3-8
Figure 3.2	Distribution of the Elderly Population in the Midwest Region by Gender and Age Group between 1995 and 2020	3-8
Figure 3.3	Distribution of the Elderly Population in the South Region by Gender and Age Group between 1995 and 2020	3-9
Figure 3.4	Distribution of the Elderly Population in the West Region by Gender and Age Group between 1995 and 2020	3-9
Figure 3.5	Licensed Drivers by Gender and Age Group, 1963–1995	3-18
Figure 3.6	Fatalities of Drivers Age 65 or Over from 1980–1997	3-33
Figure 3.7	Comparison of Selected Causes of Death, by Age Group, 1996 Data	3-36
Figure 5.1	Projected National Non-Institutionalized Population	5-4
Figure 6.1	Active Drivers as a Percentage of the Population, 1977-1995	6-1
Figure 6.2	Projected Active Drivers as a Percentage of the Population	6-10
Figure 7.1	Annual Vehicle Miles of Travel per Driver, 1977-1995	7-2
Figure 7.2	Average Person Trips per Person by Mode of Transportation and Trip Purpose, for Individuals under 65 and Individuals 65 and Over	7-2
Figure 7.3	Annual Projected Vehicle Miles of Travel per Driver	7-14
Figure 8.1	Historical Elderly Driver Fatality Rate by Age	8-2
Figure 8.2	Historical Elderly Driver Fatality Rate by Region	8-2
Figure 8.3	Projected Driver Risk By Age	8-13
Figure 8.4	Projected Driver Fatalities By Age	8-15
Figure 9.1	Component Contributions to 2025 Driver Fatality Projections, Men	9-5
Figure 9.2	Component Contributions to 2025 Driver Fatality Projections, Women	9-5
Figure 9.3	Projected VMT, Men	9-15
Figure 9.4	Projected VMT, Women	9-16
Figure 9.5	Component Contributions to Driver Fatality Projections Using Lower- Bounded VMT, Men	9-17
Figure 9.6	Component Contributions to Driver Fatality Projections Using Lower- Bounded VMT, Women	9-18

LIST OF TABLES

Table ES-1	Elderly Driver Fatality Projections, Male and Female	ES-6
Table ES-2	Total Fatality Projections, Male and Female	ES-6
Table ES-3	Elder Driver Fatality Projections for 2025 (as Percentages of 1995 Driver Fatalities)	ES-6
Table 1.1	Older Driver Research Projects Sponsored by General Motors Corporation	1-2
Table 3.1	Population Projections for the Total United States, by Age Group, for the Years 2000–2025, with Comparison to the 1995 Population	3-3
Table 3.2	Projected Ratios of Men to Women, Total United States, Compared with the 1995 Ratios	3-4
Table 3.3	Median Household Income by Type of Household for Selected Years . .	3-5
Table 3.4	Mean Income for the Elderly, by Gender	3-5
Table 3.5	Comparison of Changes in Percentages of the Elderly in the General Population and in a Count of Total Traffic Fatalities, 1986-1996	3-35
Table 4.1	Data Sources Examined	4-10
Table 5.1	NHIS Activity Limitation Status Regression Coefficients and T-Values	5-7
Table 6.1	Regression Results for the Probability of Continuing to Drive	6-4
Table 6.2	Determinants of Projected National Driver Growth	6-12
Table 6.3	Determinants of Projected Regional Driver Growth	6-12
Table 7.1	VMT Regressions Results	7-7
Table 7.2	Determinants of Projected National VMT Growth, 1995-2025	7-15
Table 7.3	Determinants of Projected Regional VMT Growth	7-16
Table 8.1	Driver Crash Rate Regression	8-7
Table 8.2	Total Risk Crash Rate Regression	8-9
Table 8.3	The Determinants of Projected Changes in Driver Risk, National Level	8-14
Table 8.4	The Determinants of Projected Changes in Driver Risk, Regional Level	8-16
Table 9.1	Sensitivity of Total Driver Fatalities to Perturbations in Independent Variables: Elasticities of Projected Driver Fatalities in 2025	9-6
Table 9.2	Sensitivity of 2025 Projections to Perturbations in Income Growth . . .	9-10
Table 9.3	Sensitivity of 2025 Projections to Perturbations in Projected Employment Status	9-10
Table 9.4	Sensitivity of 2025 Projections to Perturbations in Projected Percentage of Elderly Households with Other Drivers	9-11
Table 9.5	Sensitivity of 2025 Projections to Perturbations in Projected Trend in Health Status	9-11
Table 9.6	Sensitivity of 2025 Projections to Perturbations in Projected Urbanization	9-12

Table 9.7	Sensitivity of 2025 Projections to Perturbations in Projected Seat Belt Use	9-12
Table 9.8	VMT Projections for 2025 with and Without Pure Time Effects and with Improving Health Status, National Level	9-15
Table 9.9	Comparison of 2025 National Driver Fatality Projections, with Upper-bounded and Lower-bounded VMT Projections	9-17
Table 10.1	Older Driver Fatality Projections by Age Group, Male and Female . . .	10-2
Table 10.2	Total Fatality Projections by Age Group, Male and Female	10-2
Table 10.3	Burkhardt et al. and ORNL Projections of Elderly Driver Fatalities as a Percent of 1995 Traffic Fatalities	10-4
Table 10.4	Wiggers' and ORNL's Projections of Elderly Traffic Fatalities as a Percent of Historical Fatalities	10-6
Table 10.5	Elder Driver Fatality Projections for 2025	10-9
Table A.1.1	Projections of Vehicle Miles of Travel, Males, in Miles Driven	A-1
Table A.1.2	Projections of Vehicle Miles of Travel, Males, as Percents of 1995 Averages	A-2
Table A.1.3	Projections of Vehicle Miles of Travel, Females, in Miles Driven	A-3
Table A.1.4	Projections of Vehicle Miles of Travel, Females, as Percents of 1995 Averages	A-4
Table A.2.1	Projections of Drivers in Age Groups, Males, Percentages	A-5
Table A.2.2	Projections of Drivers in Age Groups, Males, as Percentages of 1995 Percentages	A-6
Table A.2.3	Projections of Drivers in Age Groups, Females, Percentages	A-7
Table A.2.4	Projections of Drivers in Age Groups, Females, as Percentages of 1995 Percentages	A-8
Table A.3.1	Elder Driver Fatality Rate Projections, Males, Deaths per 100 Million Miles Driven	A-9
Table A.3.2	Elder Driver Fatality Rate Projections, Males, Deaths per 100 Million Miles Driven, as Percentage of 1995 Rates	A-10
Table A.3.3	Elder Driver Fatality Rate Projections, Females, Deaths per 100 Million Miles Driven	A-11
Table A.3.4	Elder Driver Fatality Rate Projections, Females, Deaths per 100 Million Miles Driven, as Percentage of 1995 Rates	A-12
Table A.4.1	Projected Elderly Driver Fatalities, Males, Total Number of Fatalities	A-13
Table A.4.2	Projected Elderly Driver Fatalities, Males, Total Number of Fatalities as Percent of 1995 Fatalities	A-14
Table A.4.3	Projected Elderly Driver Fatalities, Females, Total Number of Fatalities	A-15
Table A.4.4	Projected Elderly Driver Fatalities, Females, Total Number of Fatalities as Percent of 1995 Fatalities	A-16
Table A.5.1	Projected Total Fatality Rate Attributed to Male Drivers, Deaths per 100 Million Miles	A-17
Table A.5.2	Projected Total Fatality Rate Attributed to Male Drivers, Deaths per 100 Million Miles, as Percentage of 1995 Rates	A-18

Table A.5.3	Projected Total Fatality Rates Attributed to Female Drivers, Deaths per 100 Million Miles	A-19
Table A.5.4	Projected Total Fatality Rates Attributed to Female Drivers, Deaths per 100 Million Miles, as Percent of 1995 Rates	A-20
Table A.6.1	Projected Total Fatalities Attributed to Male Drivers, Number of Fatalities	A-21
Table A.6.2	Projected Total Fatalities Attributed to Male Drivers, as Percentage of 1995 Fatalities	A-22
Table A.6.3	Projected Total Fatalities Attributed to Female Drivers, Number of Fatalities	A-23
Table A.6.4	Projected Total Fatalities Attributed to Female Drivers, as Percentage of 1995 Fatalities	A-24
Table B.1	Projections of Non-Institutionalized Population, Males	B-2
Table B.2	Projections of Non-Institutionalized Population, Males, as Percent of 1995 Population	B-3
Table B.3	Projections of Non-Institutionalized Population, Females	B-4
Table B.4	Projections of Non-Institutionalized Population, Females, as Percent of 1995 Population	B-5
Table B.5	Male DRI Income Projections	B-8
Table B.6	Female DRI Income Projections	B-9
Table B.7	Ratio of Average 1995 NPTS Income to 1995 DRI Estimates, by Gender and Age	B-10
Table B.8	Employment Status Projections as a Percent of Population	B-11
Table B.9	<i>Other Driver</i> Projections as a Percent of Population	B-11
Table B.10	National Seat Belt Use Projections	B-12
Table B.11	Percent of Population in Urban Areas, 1990 Census	B-12
Table C.1	Average VMT per Person of Southern Men, 1995 NPTS and Adjusted Numbers	C-1
Table C.2	Year Coefficients (Adjusted and Non-Adjusted, and 1977-90/1977-95 Coefficient Ratios)	C-4