AN ABSTRACT OF THE THESIS OF

Michael Rathsam for the degree of Master of Science in Environmental Health Management presented on May 3, 1996. Title: A Comparison of Alcohol-Related Morbidity, Mortality, and Seatbelt Use Before and After Oregon's Adoption of Primary Seatbelt Legislation.

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Reducing the number of intoxicated motorists and increasing seatbelt use are two strategies that have effectively reduced morbidity and mortality. The National Highway Traffic Safety Administration (NHTSA), however, suggests that reductions in alcohol-related fatalities and injuries are the result of implementing strategies associated with enforcement and judicial processing of driving while intoxicated (DWI) laws. Accepting this suggestion makes it easy to overlook any contribution made by seatbelts. No studies could be found that examined how seatbelt use, as well as morbidity and mortality, changed among intoxicated motorists after enactment of primary seatbelt laws.

Mortality data was obtained from the National Highway Traffic Safety Administration's (NHTSA) Fatal Accident Reporting System (FARS). Morbidity data was obtained from the Oregon Department of Transportation (ODOT), Traffic Safety Section. The factors of gender, age, alcohol involvement, and seatbelt use were used to compare 3,110 major injuries and 1,390 deaths that occurred between 1988-90 prior to

Oregon's adoption of primary seatbelt legislation with 2,304 major injuries and 1,124 deaths that occurred between 1991-93.

Males and females involved in fatal alcohol-related motor vehicle crashes were found to have had the greatest reduction in mortality after enactment of primary seatbelt legislation. The likelihood of males (involved in fatal, alcohol-related motor vehicle crashes) wearing their seatbelts after adoption of the law was 4.08 times greater than before adoption of the law (OR=4.08, 95% CI=2.68, 6.23 $p<10^{-6}$). The likelihood of females (involved in fatal, alcohol-related motor vehicle crashes) wearing their seatbelts after adoption of the law was 4.56 times greater than before adoption of the law (OR = 4.56, 95% CI=2.47, 8.49 $p<10^{-6}$).

Following adoption of seatbelt legislation, there was also a decrease in alcohol-related injuries for both males and females. The likelihood of males (involved in alcohol-related major injury crashes) wearing their seatbelts after adoption of the seatbelt law was 2.68 times greater than before adoption of the law (OR=2.68, 95% CI=1.73, 4.15 $p<10^{-5}$). The likelihood of females (involved in alcohol-related major injury crashes) wearing their seatbelt after adoption of the seatbelt law was 3.8 times greater than before adoption of the law (OR=3.80, 95% CI=2.00, 7.27 $p<10^{-5}$).

Reductions in morbidity and mortality appear to be more likely the result of increased seatbelt use rather than reduced alcohol involvement because the percent of alcohol-related mortality decreased only three percent (3%) and alcohol-related morbidity decreased only two percent (2%).

Further study is warranted to determine what factors prompt males and females involved in fatal, alcohol-related motor vehicle crashes to increase seatbelt use. Two such factors could be, (1) the "buckle-up" message itself, and (2) the heightened perception among intoxicated motorists that they may be initially stopped by enforcement officers for failure to use their seatbelt.

A Comparison of Alcohol-Related Morbidity, Mortality, and Seatbelt Use Before and After Oregon's Adoption of Primary Seatbelt Legislation.

by

Michael Rathsam

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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INTRODUCTION

Motor vehicle crashes are the leading cause of death in the United States for people aged 1-34 years old (Karpf and Williams, 1983). They account for more than 40% of all mortality among people in their late teens. They also cause more deaths of people 1-75 years old than any other injury-producing event. Automobile crashes are associated with more than 500,000 annual hospital admissions (Rice, MacKenzie and Associates, 1989) and with 57% of all head-injury-related deaths (Sosin, Sacks, and Smith, 1989). Automobile crashes have also been found to cause 44 percent of all brain injuries diagnosed by a physician (Kraus, Franti, Riggins, Richards, and Borhani, 1975), 56 percent of acute spinal cord injuries, and 20 percent of facial injuries treated in emergency rooms (Karlson, 1982). The resulting annual financial burden to society has been estimated at nearly $50 billion, including indirect costs (Rice, MacKenzie and Associates, 1989).

Two of the most well known strategies to reduce crash-related morbidity and mortality involve; (1) reducing drunk driving and (2) increasing seatbelt use. The rationale for reducing drunk driving is that 34% to 50% of all crash fatalities involve alcohol; therefore, reducing the numbers of intoxicated motorists should reduce the overall number of fatalities. The rationale for mandatory occupant protection laws is that the risk of serious injury and fatality is reduced by 50% when a motor vehicle occupant is

wearing a seat belt during a crash (Robertson, 1983). It has been well documented that after adoption of mandatory occupant protection laws, seat belt use increases and, as a result, deaths and injury severity decline (Wagenaar and Margolis, 1990).

Governmental agencies and numerous private organizations have worked and continue to work at preventing drunk driving. Their efforts, however, are commonly overshadowed by large-sized, high cost, high visibility advertising campaigns promoting alcoholic beverage consumption. The common, sobering prevention message, which admonishes drivers not to *"drink and drive"* simply can't compete with the upbeat, glitzy, commonly sexually stimulating messages delivered by the alcoholic beverage industry to influence increased sale of their products. Between 1982-1993, efforts to reduce alcohol-related motor vehicle crash morbidity and mortality have yielded approximate 1% reductions each year (NHTSA, 1995). State and local governments have enacted regulations to limit alcohol use to reduce alcohol availability and prevent social problems that arise from excessive alcohol consumption. These regulations address legal drinking age and taxes, restrictions on hours of sale, type and density of outlets; and changes in criminal justice enforcement practices. The effects of restrictive policies, particularly in relationship to drunk driving, have been evaluated by researchers, but have not provided consistent results (Markowitz, 1989; Smith, 1988). Additional strategies implemented by state and local governments include; altering social norms to make drunk driving socially unacceptable, limiting alcohol availability among underage youth, implementing responsible alcohol service training for those who sell and serve alcohol, implementing early alcohol treatment and rehabilitation programs, offering

alternative transportation programs for those of legal drinking age, and increasing the perception of risk for arrest for drunk driving (Fell, Hedlund, Vegaga, Klein, and Johnson, 1994).

The National Highway Traffic Safety Administration (NHTSA) has concluded that additional reductions in alcohol-related traffic fatalities, despite a 42% increase in vehicle miles traveled since 1982, were the result of prompt license suspension for persons who drive while intoxicated; lowering legally permissible blood alcohol content (BAC) levels; sobriety checkpoints; public education, community awareness, and media campaigns about the dangers of drunk driving (Fell, Hedlund, Vegaga, Klein, and Johnson, 1994). Despite efforts to reduce drunk driving, alcoholic beverages remain conveniently available in America and in 1992 alone, this country experienced 17,700 alcohol-related deaths and 355,000 alcohol-related traffic injuries (Fell, Hedlund, Vegaga, Klein, and Johnson, 1994).

Between 1988-1993, Oregon experienced an average of 48,850 motor vehicle crashes each year. Of these, an annual average of 22,086 (45%) were fatal or injury producing events. A total of 3,358 people died in Oregon crashes during this period; of these deaths, 1,492 (44%) involved alcohol (Oregon Dept. of Transportation, 1995).

As much as regulatory actions and special strategies to reduce drunk driving contribute to decreased morbidity and mortality, it is also plausible that decreases may also be attributable to other, non-DWI related intervention strategies. Strategies that address minimum safety standards, improved crashworthiness of automobiles, and seatbelt use must also be considered. This study addresses how one of these strategies,

adoption and enforcement of primary occupant protection laws, has impacted seatbelt use among alcohol-related fatalities and major injuries in the State of Oregon.

Purpose of Study

The purpose of this study was to examine whether adoption of Oregon's primary, enforceable, seatbelt legislation affected morbidity, mortality, and seatbelt use among victims of alcohol-related motor vehicle crashes. If seatbelt use increased among victims of alcohol-related crashes during periods of decreased morbidity and mortality, then it might be argued that the law contributed to that effect. In this study, the variables of gender, age, seatbelt use, and alcohol involvement were examined. The research questions for this study were as follows:

1). After enactment of primary seatbelt legislation, were there changes in the percentage of seatbelt use among alcohol-related crash victims?

2). After enactment of primary seatbelt legislation, were there changes in morbidity and mortality among alcohol-related crash victims?

3). After enactment of primary seatbelt legislation, were there changes in gender, age, and/or alcohol involvement among motor vehicle crash victims.

Definition of Terms

Blood Alcohol Content (BAC) - The percent of alcohol present in the bloodstream after consumption of alcoholic beverages.

Driving While Intoxicated (DWI) - Operating a motorized vehicle while intoxicated at a level greater than the legally permissable BAC.

ETOH - Is a term used to represent alcohol (ethanol).

Primary Seatbelt Laws - Allow law enforcement personnel to cite, and fine, motorists solely on the basis of non-use of seatbelts or occupant protection systems.

Secondary Seatbelt Laws - Allow law enforcement personnel to cite, and fine, motorists for non-use of seatbelts or occupant protection systems only if the motorist has been stopped for another reason.

Dram Shop Laws - Laws which hold alcoholic beverage retailers liable for intoxicated customers.

LITERATURE REVIEW

A national telephone survey on occupant protection issues showed that twenty-three percent of the United States population age 16 and older (45 million people) have been injured in a motor vehicle crash that required medical attention (NHTSA, 1996). Of these twenty-three percent, thirteen percent were unable to resume one or more activities a year after the crash. Thus, approximately 6 million people over the age of 15 have suffered long term or permanent activity impairment as a result of vehicle crashes (NHTSA, 1996).

Alcohol-related Morbidity and Mortality

Zador (1991) found, in a comparison of single vehicle, alcohol-related fatalities among males and females, that for each agegroup (16-20, 21-24, 25+) the risk of being involved in a fatal crash doubled with each 0.02 percent increase in BAC (Blood Alcohol Content). Zador (1991) also found that younger drivers with BACs in the 0.05-0.09 range had higher relative risks than older drivers; and females had higher relative risks than males.

During the 1980's, 44,000 to 52,000 deaths and 4 million to 5 million injuries occurred each year from motor vehicle crashes (Baker, O'Neill, Ginsburg, and Li, 1992), but the percentage of alcohol-related fatalities dropped 10 percent (Klein and Burgess, 1992). In 1992, this country experienced 17,700 alcohol-related traffic deaths and 355,000 alcohol-related traffic injuries (Fell, Hedlund, Vegaga, Klein, and Johnson, 1994). In 1993, 40,115 persons were killed as a result of traffic crashes. Of these, 34.9% (13, 982) occurred in crashes in which a driver or non-occupant was drunk (NHTSA, 1995). During the 12 year period between 1982 and 1993, alcohol involvement in fatal crashes declined from 46.3% to 34.9% (NHTSA, 1995). This overall 11.4% drop across 12 years in alcohol involvement occurred at a rate of just less that 1% per year.

Relatively few observational studies have been conducted to determine the actual incidence of alcohol-impaired drivers on U.S. roads. One such study was conducted by Lund and Wolfe (1991). Their 1986 survey of 32 randomly selected localities across the country produced results that indicate 3.1% of late-night weekend drivers have blood

concentrations of 0.10% or more. This was a reduction of 1.8% from the 4.9% observed in 1973. They also found 8.3% of the 1986 drivers were at, or above, a 0.05% BAC, compared to 13.5% in 1973; this was a reduction of 5.2%.

Sloan, Reilly, and Schenzler (1994) found no evidence that mandatory jail terms for DUI reduced alcohol-related mortality. They also found that laws requiring mandatory minimum fines, or a minimum period of license revocation, were not significant for reducing mortality in their preliminary analysis. They did determine, however, that reductions in alcohol-related mortality might be achievable through a combination of public policies: (1) increased price of alcohol, (2) dram shop laws, (3) and policies that are not directly alcohol related, such as increased jail protection.

The NHTSA records all fatal traffic crashes, from each state, in a database known as the Fatal Accident Reporting System (FARS). NHTSA defines intoxication in terms blood alcohol content (BAC) at levels greater than 0.10%. The BAC reporting rate by states into FARS, although improved, is at 73% for fatally injured drivers and 25% for surviving drivers (NHTSA, 1995). Substantial estimation of BAC levels is therefore required before valid statistics can be determined on the role of alcohol in fatal crashes.

Seatbelt Use Laws

A 1990 study of seatbelt use in 19 U.S. cities showed that seatbelt use doubled after adoption of seatbelt legislation (Datta, 1990).

A daytime observational seatbelt use study in Michigan found that although seatbelt use more than doubled immediately following implementation of mandatory

(secondary) seatbelt law, use declined from 58.4% to 43% within 5 months. Despite that decline, it was noted that belt use remained 117% higher than the 19.8% measured before passage of the Michigan law (Wagenaar and Wiviott, 1986).

Georgia enacted mandatory (secondary) seatbelt legislation in September, 1988. A study comparing mortality during the 12 month period immediately preceding the enactment of the law with that during the following 12 month period showed no statistically significant reduction (Thyer and Robertson, 1993). It was further noted that there was a 1.5% decrease in deaths (from 136 to 134 per month) and the mean number of monthly injuries declined from 8,139 to 8,108. This decrease of 31 injuries per month was less than a 1% decrease in morbidity. Direct observational seatbelt use surveys in Georgia have confirmed that motorists have increased seatbelt use from 20% in 1988 to just over 40% in 1990 (Martin, Kingery, Shinholser, and Helms-Nelson, 1991).

A recent study by Robertson (1996) considered factors associated with vehicle crashworthiness, economic conditions, observed seatbelt use, and percentage of drivers with a BAC greater than 0.10% by weight in a given calendar year. The results of the study not only supported the conclusion that car occupant deaths have been substantially reduced by safety standards and publicized crash tests leading to increased crashworthiness, but that seatbelt use and reduced alcohol use had additional positive effects.

Seatbelt Use Among Intoxicated Motorists

Lund and Wolfe (1990) reported an increase in seatbelt use among drunk drivers from 31% in 1973 to 55% in 1986. Foss, Beirness, and Sprattler (1994) identified trends

of observed seatbelt use in Minnesota among three groups of intoxicated motorists. These groups included; drunk drivers driving without passengers, drunk drivers driving with passengers, and drunk passengers. They observed a dose-response relationship between increased blood alcohol content (BAC) and decreased seatbelt usage among drunk drivers among the latter two of these groups. However, they also noted that a dose-response relationship did not apply to intoxicated drivers who were driving without passengers. Even at the highest BAC (150 mg/kL and above) levels, seatbelt usage among this group stabilized at 40%, while usage among drunk drivers with passengers fell to 12% and further to 3% among intoxicated passengers (Foss, Beirness, and Sprattler, 1994). NHTSA has documented that intoxicated drivers are restrained much less frequently than sober drivers and that drivers who use their safety belts are much less likely to have been drinking than unrestrained drivers (NHTSA, 1995.)

Minnesota also has a mandatory (secondary) seatbelt use law; passed in August, 1986. A night-time observational seatbelt use study among intoxicated motorists was conducted in Minnesota during September, 1990. That study found that drivers with a BAC greater than 0.10% were substantially less likely to be wearing a seatbelt (OR=2.17) and that belt use was more common among females (OR=2.02) (Foss, Beirness, and Sprattler, 1994).

History of Oregon's Seatbelt Legislation

Oregon's legislative involvement with seatbelts began in 1968 when the legislature voted to require them in all cars. Then, in 1972, the legislature voted to

require both lap and shoulder, as separate units, in all cars. In 1974, the legislature voted again to improve the separate lap and shoulder belt units by requiring three point safety belt systems in all cars (ODOT, 1996).

Oregon's first attempt to enact seatbelt use legislation was in 1977 (House Bill 2550). It passed the House but failed to make it out of Senate Committee before adjournment. House Bill 2550 re-emerged in 1979 but this time it failed in the House. It was reintroduced twice more in 1979, once as House Bill 2667 (failed) and then as House Bill 2551. This time it passed the house, but was tabled in the Senate.

In 1981, Senate Bill 424 was written to require children under age 13 to be buckled when riding in the front seat. It passed in the Senate, but failed in the House. Another Senate Bill, 667, was also introduced in 1981. This bill would have required the operator of state-owned vehicles to use seatbelts. Senate Bill 667 failed in the Senate.

Senate Bill 293 was introduced in 1983. This bill required children up to age 5 to be in a child safety system or safety belt. It passed both the House and the Senate and became law on January 1, 1984 with fines after July 1, 1984.

In 1985, Senate Bill 342 was introduced. This bill required children under 16 years to be in a child safety system or safety belt. It also required children under one year of age to be in a child safety system. Senate Bill 342 passed both the House and Senate and became effective January 1, 1986.

In 1987, Senate Bill 87 was introduced and passed both the Senate and the House. This bill was referred to the people, for vote during the November, 1988 General Election, Ballot #3. The bill proposed to require both drivers and passengers to use

safety belts or child safety systems. It also required vehicle owners to maintain safety belts in working condition (Class D traffic infraction).

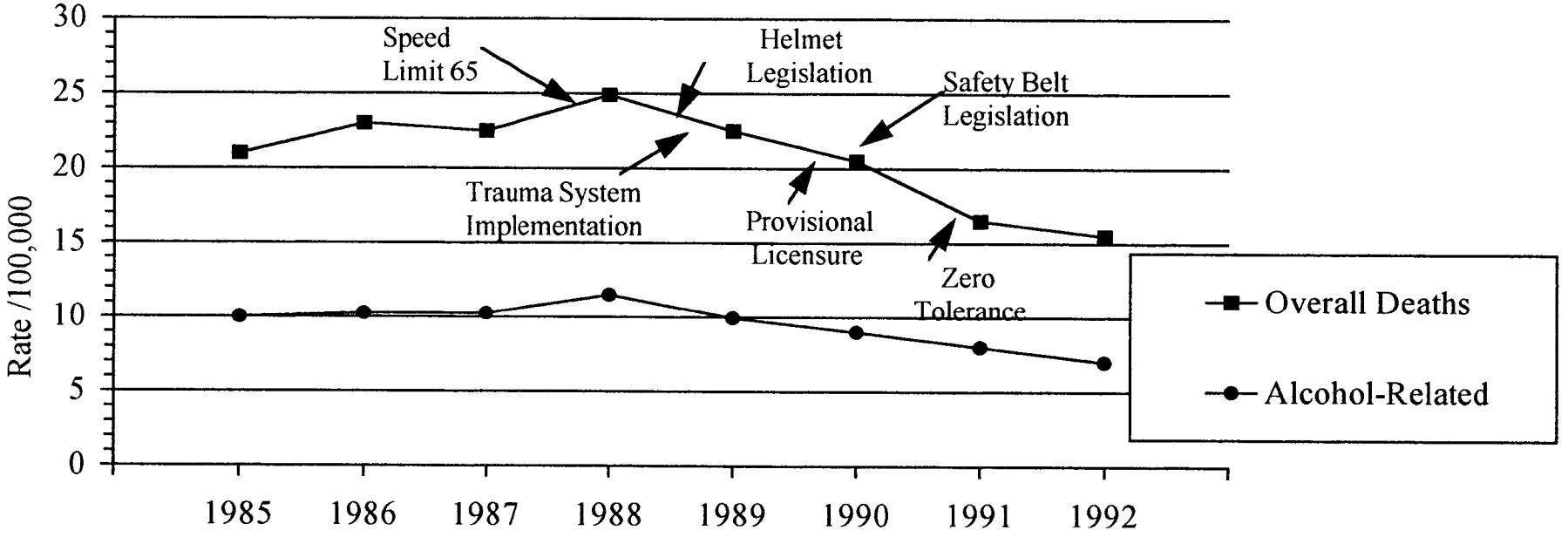
In 1988, Ballot Measure #3 was voted upon in General Election. It failed. Virtually the same legislation was reintroduced in 1990 as ballot measure #9. This time it was passed by the public on November 6, 1990 and became effective on December 7, 1990. Oregon's enactment of primary seatbelt legislation in 1990 culminated 13 years of effort in the State's legislature (ODOT, 1996).

In 1993, Senate Bill 779 passed, effective November 4, 1993. This bill required children under four years of age and weighing 40 pounds or less to be in child safety system (Class D traffic infraction).

Chronology of Intervention Strategies and Mortality Rates

In 1985, Oregon's overall motor vehicle fatality rate was 21/100,000 Oregon residents (See Figure 1). It increased to 23/100,000 in 1986-87 and then to its' highest level, 25/100,000 in 1988 after Oregon increased the speed limit to 65 miles per hour. During 1988 two strategies were implemented. The first was implementation of a Trauma System and the second was enactment of motorcycle helmet legislation. The Trauma System was created by Oregon Revised Statute (ORS) 431.607 and the implementing regulations are set forth as Oregon Administrative Rules (OAR) Chapter 333, Divsion 200. This ORS and OAR created the Trauma System, the Oregon Trauma Registry, a State Trauma Advisory Board (STAB) and nine Area Trauma Advisory Boards (ATAB) to advise the Health Division. They further required the development of a state trauma plan and area trauma plans, which coordinate the response, care, and

Figure 1. Motor Vehicle Fatalities per 100,000 Oregon Residents 1985-1992



Source: Oregon Traffic Safety Division
Rate per 100,000 Oregon population.

transportation of injured patients (Oregon Health Division, Oregon Trauma System Biennial Report, 1991-92). In 1989, Oregon adopted a Provisional Licensure law that, when enforced, would remove the drivers license from drunk driving motorists under the age of 18. The law further lowered the BAC level for youth to 0.00%. The lower BAC level for youth was expanded to include those under age 21 September 29, 1991 (Oregon Department of Transportation, Transportation Safety Section, 1994). Also, in 1989, the motor vehicle fatality rate returned to 23/100,000. In 1990, the motor vehicle fatality rate dropped further to its lowest level (20.5/100,000) in 5 years. After several unsuccessful attempts, Oregon enacted primary seatbelt legislation on December 6, 1990. Oregon also adopted Zero Tolerance Laws during 1990 . One year after enacting mandatory (primary) seatbelt legislation, motor vehicle crash mortality dropped to 17/100,000 Oregon residents. In 1992, two years after adoption of legislation, crash mortality had dropped further to 16/100,000 Oregon residents. In the five year period between 1988 and 1992, motor vehicle crash mortality had dropped from 25/100,000 to 16/100,000. During the same time period, alcohol-related motor vehicle crash mortality dropped from 11.5/100,000 to 7/100,000 Oregon residents.

Developing Additional Countermeasure Strategies

Potential countermeasures for motor vehicle crash morbidity and mortality can be best visualized and understood through use of a nine-cell matrix known as the "Haddon Matrix" (Haddon, 1968). This model divides a crash into three phases- precrash, crash, and postcrash. Each of these phases then interact with three sets of crash factors that involve the victim, vehicle, and environment (physical and social). (See Figure 2).

Figure 2. Haddon Matrix: Factors Related to Injury.

Phases	Factors		
	Human	**Vehicle**	**Physical and Social Environment**
Pre-crash	Fatigue Alcohol intoxication Amount of Travel Driver vision	Brakes, tires Center of gravity Speed capability Load weight	Laws related to alcohol and driving Seatbetl laws Visiblity of hazards Speed limits
Crash	Seatbelt use Age Sex Osteoporosis	Vehicle size Speed at impact Load containment	Recovery areas Speed limits Median barriers Shoulder slope
Post Crash	Age Physical condition	Fuel system integrity	Emergency response Distance to and quality of medical services Rehabilitation programs

* Example from the Injury Fact Book, 1992 Edition

While the Haddon Matrix allows for the development of interventions designed specifically for each cell, it also provides a constant reminder that a single strategy alone, cannot be expected to provide, nor be credited with, reductions in injury and/or death. Most intervention efforts, for decades, focused on the precrash phase in the environment (physical and social) cell in efforts to change driving behavior. Such interventions include; laws related to alcohol and driving, speed limits, signalization, roadway curvatures and gradient, speed limits, and roadway hazards. Today, a more balanced approach addresses modifiable events in the crash and post-crash phases (Baker, O'Neill, Ginsburg, and Li, 1992).

Haddon's Matrix has been used by numerous governmental agencies, as well as businesses and private organizations, in the development and implementation of intervention strategies to reduce motor vehicle crash-related morbidity and mortality. The enactment and enforcement of primary seatbelt legislation is such a strategy.

MANUSCRIPT

A Comparison of Alcohol-Related Morbidity, Mortality, and Seatbelt Use Before and After Oregon's Adoption of Primary Seatbelt Legislation.

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Abstract

Objectives

To determine the effect of Oregon's primary seatbelt law on seatbelt use, major injury, and death among victims of alcohol-related motor vehicle crashes.

Methods

Mortality data was obtained from the National Highway Traffic Safety Administration's fatal accident reporting system (FARS). Morbidity data was obtained from the Oregon Department of Transportation (ODOT), Transportation Safety Section. Additional driving while intoxicated (DWI) arrest data was obtained from ODOT and analyzed.

Results

The greatest reduction in mortality occurred among males and females involved in alcohol-related motor vehicle crashes. Males and females involved in fatal alcohol-related motor vehicle crashes were also found more likely to buckle-up (odds ratio of males=4.08 and females=4.56) than those non-alcohol related (odds ratio of males=2.83 and females=3.05) . These changes occurred despite only slight reductions in percentages of alcohol-related mortality (3%) and morbidity (2%). Furthermore, they occurred at a time when the median DWI arrest rate dropped from 41.01 per 10,000 population in 1988-90, to 35.36 per 10,000 during 1991-93.

Conclusions

Primary seatbelt legislation may have increased the percentage of seatbelt use among both among fatal and major injury victims resulting in reductions of fatal and

major injury cases. Perhaps motorists involved in alcohol-related motor vehicle crashes perceived a greater risk of arrest from non-use of seatbelts than from driving while intoxicated.

Introduction

Motor vehicle crashes are the leading cause of death in the United States for people age 1-34.[1] In 1992, this country experienced 17,700 alcohol-related deaths and 355,000 alcohol-related traffic injuries at a cost approaching $50 billion.[2] Motorized vehicles are associated with more than 500,000 annual hospital admissions, and with 57% of all head injury related deaths.[2,3] Motor vehicles have also been found to cause 44 percent of all brain injuries diagnosed by a physician, 20 percent of facial injuries treated in emergency rooms[5], and 56% of spinal cord injuries.[4,5] The rationale for mandatory seatbelt use laws is that the risk of serious injury and fatality is reduced by 50% when a motor vehicle occupant is wearing a seatbelt during a crash.[6] Reductions in alcohol-related motor vehicle crash morbidity and mortality are believed to be the result of increased driving while intoxicated (DWI) arrests, swift court processing, and increased penalty.[7] No studies, however, could be found that examined how the adoption of primary seat belt laws affect seatbelt use among motor vehicle occupants involved in alcohol-related fatal and major injury crashes.

The purpose of this study was to examine how primary, enforceable, seatbelt legislation affected seatbelt use among victims of alcohol-related motor vehicle crashes with regards to age, gender, and alcohol involvement.

Methods

This retrospective cohort study compared motor vehicle crash morbidity and mortality in the State of Oregon before and after adoption of a primary seatbelt law enacted on December, 6, 1990. A cohort consisting of all who died or sustained major injury in crashes in Oregon during a three-year period before adoption of the law was compared to a cohort that died or sustained major injury following enactment of the law. Each cohort was examined by age, gender, alcohol involvement, and seatbelt use.

Mortality data was obtained from the National Highway Traffic Safety Administration's (NHTSA) Fatal Accident Reporting System (FARS)[8] and morbidity data was obtained from the Oregon Department of Transportation (ODOT), Traffic Safety Section.[9]

According to the FARS data, 3,358 motor vehicle crash fatalities occurred in Oregon between 1988 and 1993. Of these, 1,882 (56%) occurred during the period 1988-90 and 1,476 (44%) occurred during the period 1991-93, after Oregon adopted primary enforced seatbelt legislation. These deaths, however, also included those associated with: motorcycles (n=149); pedestrians (n=356); bicyclists (n=70); and others (n=2) that were not affected by seat belt legislation. These cases, along with 249 others in which seat belt use could not be verified, were excluded from the study. The remaining 2,514 cases qualified for inclusion in this study. Of these, 1,390 (55%) occurred during the 1988-90 period and 1,124 (45%) occurred during the 1991-93 period.

This study used major injury data from ODOT's Traffic Safety Section for 6,990 individuals. Excluding cases in which seatbelt usage was not known and those that

involved motorcycles, bicycles, or pedestrians, 5,414 cases remained eligible for inclusion in this study. The variables of age, gender, seatbelt use, and alcohol involvement were also examined for this data set. Of these, 3,110 (57%) occurred during the 1988-90 period and 2,304 (43%) occurred during the 1991-93 period.

Therefore, the final sample included 1,390 deaths and 3,110 injuries for the three year period (1988-90) prior to Oregon's passage of a primary seatbelt law and 1,124 deaths and 2,304 major injuries for the three year period (1991-93) immediately following passage of the law on December 6, 1990.

The Oregon Department of Transportation (ODOT) classifies injury into 3 categories. Major injuries are defined as any injury other than a fatal injury that prevents the injured party from walking, driving, or normally continuing the activities he/she was capable of performing before the injury occurred. They include: severe lacerations, broken or distorted limbs, skull or chest injuries, abdominal injuries, unconscious at or when taken from the accident scene, or unable to leave accident scene without assistance.[10] Moderate injuries are defined as any injury other than a fatal or incapacitating injury which is evident to observers at the scene of the accident. This category includes lump on the head, abrasions, bruises, or minor lacerations.[10] Minor injuries are defined as any injury (bodily harm) reported or claimed that is not a fatal, incapacitating, or non-incompacitating injury. Minor injuries include momentary unconsciousness, limping, complaint of pain, nausea, or hysteria.[10]

To evaluate whether changes in the level of DWI enforcement affected changes in morbidity and mortality, DWI arrest data was also obtained from ODOT- Transportation

Safety Section[11] for each of the six years studied. Average arrest rates were calculated for each cohort during each time period.

Data has been expressed in terms of proportional morbidity and mortality, odds ratios, and chi-square. The Centers for Disease Control (CDC) shareware program EPI-INFO was the program used for both data management and analysis.

Results

Between 1988-1990, before the enactment of primary seatbelt legislation, 923 (66%) of the 1390 fatalities were male and 467 (34%) were female. Between 1991-93, after the passage of the legislation, 720 (60%) of the 1124 fatalities were male and 404 (40%) were female. A total of 266 fewer deaths occurred following adoption of seatbelt legislation. Of these, males sustained 203 fewer deaths and females 63 fewer deaths. Overall, the percentage of deaths among males decreased 6 percent while the percentage of deaths among females increased 6 percent.

Of the 3,110 major injuries that occurred during the period 1988-90, 1,540 (49%) were male and 1,570 (51%) were female. Of the 2,304 major injuries that occurred during the period 1991-93, 1,157 (50%) were male and 1,147 (50%) were female. A total of 806 fewer major injuries occurred during the three year period following adoption of seatbelt legislation. Of these, males sustained 383 fewer major injuries and females sustained 423 fewer major injuries. Overall, the percentage of major injuries among males increased 1% compared to a 1% decrease among females.

Figure 3. Number of Fatal and Major Injuries By Time Period, Gender, and Alcohol Involvement

Fatalities	1988-1990			1991-1993		
	Total #	#Buckled	Percent	Total #	Buckled	Percent
Sober Male	446	94	20%	360	155	44%
Sober Female	306	113	37%	276	177	64%
ETOH Male	477	39	8%	360	96	27%
ETOH Female	161	21	13%	128	52	41%
TOTAL	1,390	267	19%	1,124	480	43%

Major Injuries	1988-1990			1991-1993		
	Total #	#Buckled	Percent	Total #	#Buckled	Percent
Sober Male	1,287	538	42%	991	796	80%
Sober Female	1,463	667	46%	1,080	978	91%
ETOH Male	239	73	30%	159	86	54%
ETOH Female	119	40	33%	81	52	64%
TOTAL	3,108	1,318	43%	2,311	1,912	83%

Gender, Alcohol Involvement and Seatbelt Use in Fatal Crashes

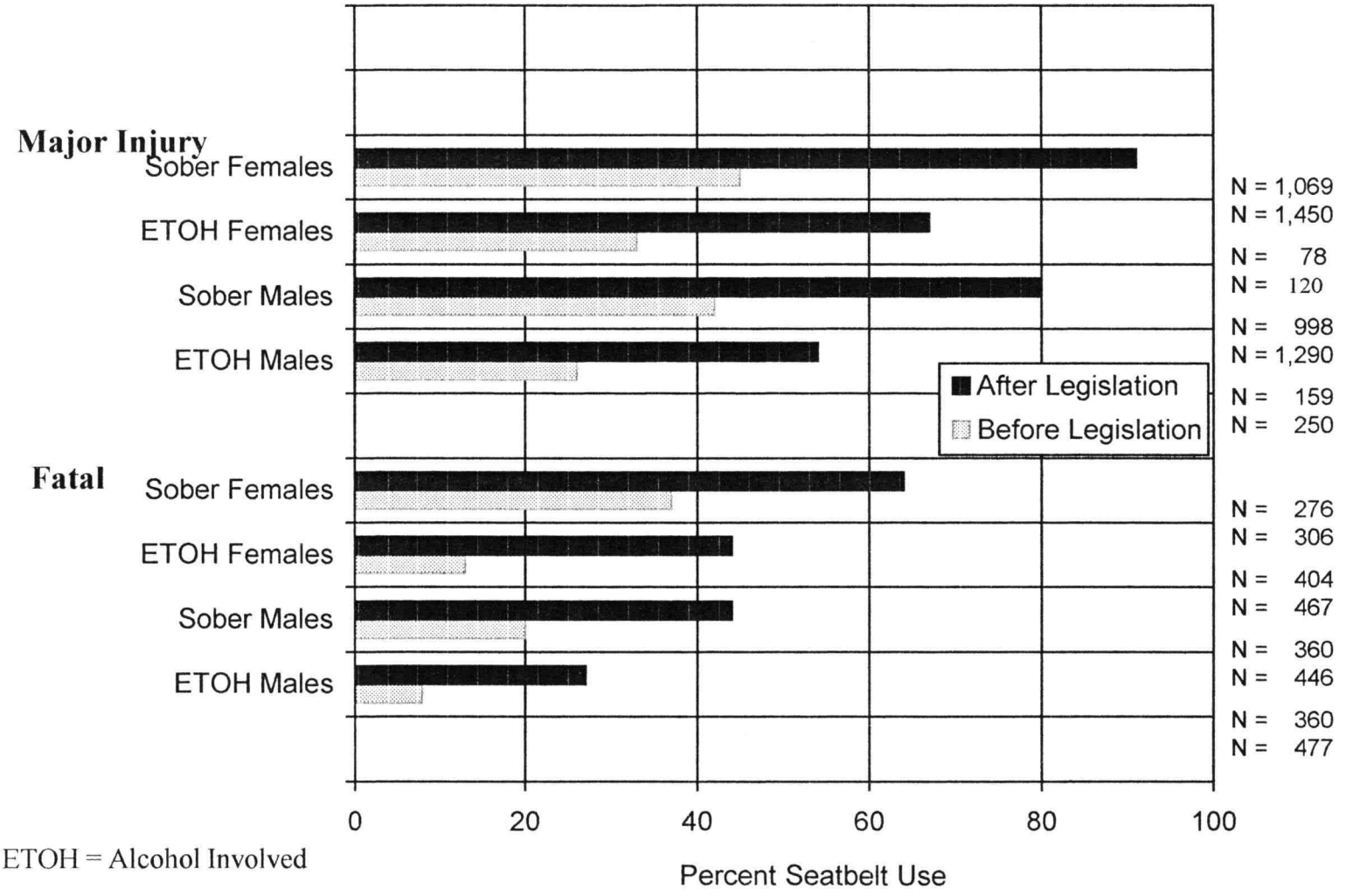
Males in Alcohol-Related Fatal Crashes

During the 1988-90 period, 477 (52%) males were involved in alcohol-related motor vehicle crashes at the time of their death. Of these, only 39 (8%) used seatbelts. By comparison, 360 (50%) males were involved in alcohol-related motor vehicle crashes at the the time of their death during the 1991-93 period. Of these, 96 (27%) used seatbelts (See Figure 3). This represented more than a three-fold increase in percent seatbelt use (See Figure 4). During the three year period following adoption of seatbelt legislation, 117 fewer alcohol-related male deaths occurred. This represented a 25% reduction in deaths. With regard to seatbelt use, the likelihood of males (involved in fatal, alcohol-related motor vehicle crashes) wearing their seatbelts after adoption of the law was 4.08 times greater than before adoption of the law (OR=4.08, 95% CI = 2.68, 6.23 $p<10^{-6}$). (See Figure 5).

Males in Non-Alcohol Related Fatal Crashes

During the 1988-90 period, 446 (48%) males died in non-alcohol related crashes. Of these, 94 (20%) used seatbelts. During the 1991-93 period, 360 (50%) males died in non-alcohol related crashes. Of these, 155 (44%) used seatbelts. This represented more than a two-fold increase in percent seatbelt use after adoption of the seatbelt law. (See Figure 4). During the three year period following adoption of seatbelt legislation, 86 fewer deaths occurred among males involved in non-alcohol related crashes, which

Figure 4. Seatbelt Use Before and After Legislation



ETOH = Alcohol Involved

represents a 19% reduction in deaths. With regard to seatbelt use, the likelihood of males (involved in non-alcohol related fatal crashes) wearing their seatbelts after adoption of the seatbelt law was 2.83 times greater than before adoption of the law (OR 2.83, 95% CI=2.06,3.90 $p<10^{-6}$). (See Figure 5).

Females in Alcohol-Related Fatal Crashes

Of the 467 females that died in crashes during 1988-90, 161 (34%) were alcohol-related. Of these, 21 (13%) used seatbelts. Of the 404 females that died during the 1991-93 period, 128 (32%) were alcohol-related. Of these, 52 (41%) used seatbelts (See Figure 3). During the three year period following adoption of seatbelt legislation, 33 fewer alcohol-related female deaths occurred, which represents a 20% reduction in deaths. With regard to seatbelt use, the likelihood of females (involved in fatal, alcohol-related motor vehicle crashes) wearing their seatbelts after adoption of the law was 4.56 times greater than before adoption of the law (OR=4.56, 95% CI=2.47, 8.49 $p<10^{-6}$). (See Figure 5).

Females in Non-Alcohol Related Fatal Crashes

Of the 306 females that died during 1988-90 in non-alcohol related fatal crashes, 113 (37%) used seatbelts. Of the 276 females that died during 1991-93 in non-alcohol related fatal crashes, 177 (64%) used seatbelts (See Figure 3). During the three year period following adoption of seatbelt legislation, 30 fewer females died in non-alcohol related crashes. This represents a 9% reduction in deaths. With regard to seatbelt use, the likelihood of females (involved in non-alcohol related fatal crashes) wearing their

Figure 5. Odds of Seatbelt Use After Adoption of Primary Legislation by Severity, Gender, and Alcohol Involvement

	Odds Ratio (95% CI)	Mantel- Haenszel Chi-Square	p Value
FATAL			
ETOH Males	4.08 (2.68, 6.23)	51.79	10^{-6}
Sober Males	2.83 (2.06, 3.90)	45.02	10^{-6}
ETOH Females	4.56 (2.47, 8.49)	28.63	10^{-6}
Sober Females	3.05 (2.15, 4.35)	42.88	10^{-6}
MAJOR INJURY			
ETOH Males	2.68 (1.73, 4.15)	22.01	10^{-5}
Sober Males	5.68 (4.67, 6.92)	342.34	10^{-6}
ETOH Females	3.80 (2.00, 7.27)	19.70	10^{-5}
Sober Females	11.44 (9.05, 14.48)	549.71	10^{-6}

seatbelts after adoption of the seatbelt law was 3.05 times greater than before adoption of the law (OR=3.05, 95% CI=2.15, 4.35 $p<10^{-6}$). (See Figure 5).

Gender, Alcohol Involvement and Seatbelt Use in Major Injury Crashes

Males in Alcohol-Related Major Injury Crashes

During the 1988-90 period, 250 (16%) males were involved in alcohol-related crashes. Of these, 65 (26%) used seatbelts. During the 1991-93 period, 159 (13%) males were involved in alcohol-related crashes. Of these, 86 (54%) used seatbelts (See Figure 4). During the three year period following adoption of seatbelt legislation , 91 fewer alcohol-related major injuries occurred, which represents a decrease of 36%. With regards to seatbelt use, the likelihood of males (involved in alcohol-related major injury crashes) wearing their seatbelts after adoption of the seatbelt law was 2.68 times greater than before adoption of the law (OR=2.68, 95% CI=1.73, 4.15 $p<10^{-5}$). (See Figure 5).

Males Involved in Non-Alcohol Related Major Injury Crashes

During the 1988-90 period, 1,290 (83%) males were involved in non-alcohol related major injury crashes. Of these, 541 (42%) used seatbelts. During the 1991-93 period, 998 (86%) males were involved in non-alcohol related major injury crashes. Of these, 798 (80%) used seatbelts (See Figure 4). During the three year period following adoption of seatbelt legislation, 292 fewer non-alcohol related male major injuries occurred, which represents a 22% decrease. With regards to seatbelt use, the likelihood of males (involved in non-alcohol related major injury crashes) wearing their seatbelts

after adoption of the seatbelt law was 5.68 times greater than before adoption of the law (OR=5.68, 95% CI=4.67, 6.92 $p<10^{-6}$). (See Figure 5).

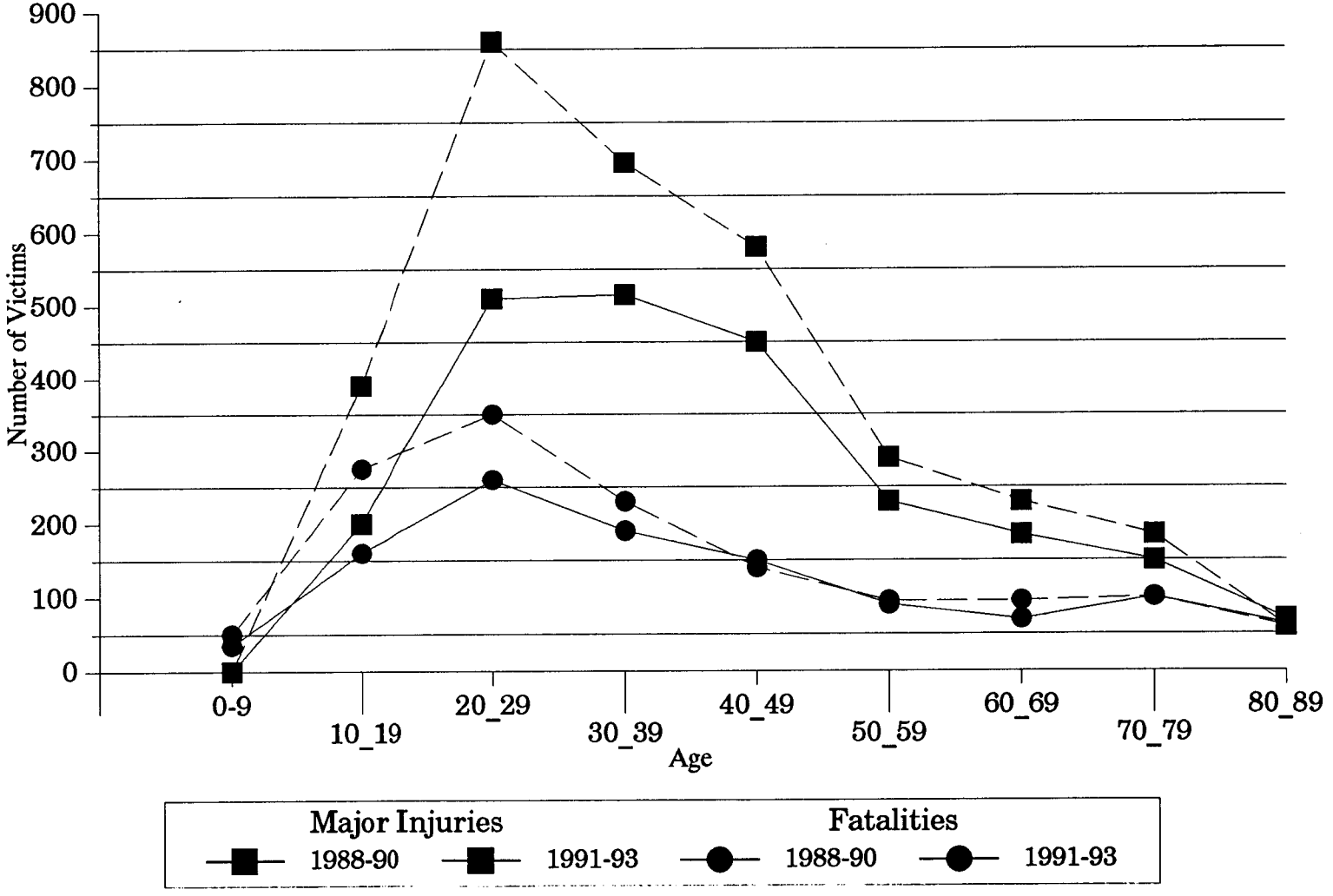
Females Involved in Alcohol-Related Major Injury Crashes

Of the 1,570 females that suffered major injury during the 1988-90 period, 120 (7%) involved alcohol-related crashes. Of these, 40 (33%) used seatbelts. Of the 1,147 females that suffered major injury during the 1991-93 period, 78 (6%) involved alcohol-related crashes. Of these, 52 (67%) used seatbelts (See Figure 4). During the three year period following adoption of seatbelt legislation, 423 fewer alcohol-related female major injuries occurred, which represents a 26% decrease in major injuries. With regards to seatbelt use, the likelihood of females (involved in alcohol related major injury crashes) wearing their seatbelts after adoption of the seatbelt law was 3.8 times greater than before adoption of the law (OR=3.80, 95% CI=2.00,7.27 $p<10^{-5}$). (See Figure 5).

Females Involved in Non-Alcohol Related Major Injury Crashes

During the 1988-90 period, 1,450 (93%) females were involved in non-alcohol related major injury crashes. 656 (45%) of these used seatbelts. During the 1991-93 period, 1,069 females also sustained major injuries in non-alcohol related major injury crashes. Of these, 969 (91%) used seatbelts (See Figure 4). During the three year period following adoption of seatbelt legislation, 381 fewer female major injuries occurred, which represents a 26% decrease in major injuries. With regards to seatbelt use, the likelihood of females (involved in non-alcohol related major injury crashes) wearing

Figure 6. Raw Numbers - Fatalities and Major Injuries By Agegroup



seatbelts after adoption of the seatbelt law was 11.44 times greater than before the law (OR=11.44, 95% CI=9.05, 14.48 $p<10^{-6}$). (See Figure 5).

Agegroups Affected

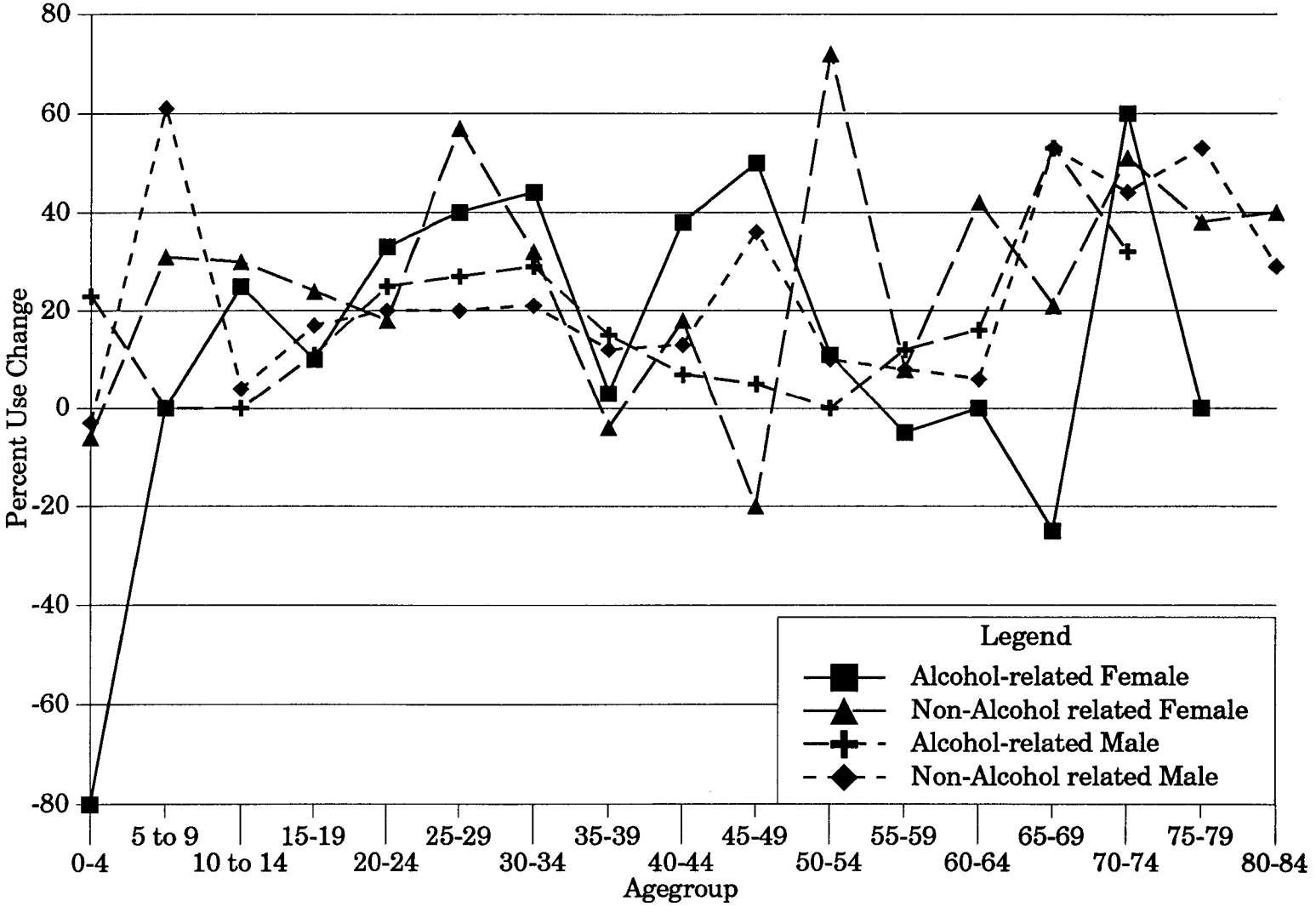
Fatalities

The number of deaths decreased among most agegroups after adoption of the law. The largest decrease in fatalities occurred in the 10-19 agegroup (24%), 20-29 agegroup (21%), 60-69 agegroup (16%), 30-39 agegroup (10%). In the 10-19 agegroup, those age 15-19 were responsible for the majority of the change as their numbers decreased from 245 in the 1988-90 period to 146 in the 1991-93 period (See Figure 6). This was a decrease of 99 deaths (40% decrease).

Major Injury

The number of major injuries among all agegroups decreased after adoption of the law with the exception of the 80 through 89 agegroup. The largest decreases in major injuries occurred in the 10-19 agegroup (30%), 20-29 agegroup (24%), and 30-39 agegroup (12%). The 20-29 agegroup was responsible for the majority of the change as their numbers decreased from 853 in the 1988-90 period to 518 in the 1991-93 period. This was a decrease of 335 major injuries (39% decrease) compared to a reduction of 183 major injuries among the 10-19 agegroup. Figure 6 illustrates the number of people sustaining major injuries in various agegroups.

Figure 7. Seatbelt Use Change Among Fatalities by Agegroup, Gender, and Alcohol Involvement



Seatbelt Use Change Among Fatals, By Agegroup

Males Involved in Alcohol-Related Fatal Crashes

Seatbelt use increased most dramatically among the 30-34 agegroup (29%), 20-24 agegroup (25%), 25-29 agegroup (27%), and 35-39 agegroup (15%) while numbers of fatalities in these combined agegroups decreased 23% from 272 (1988-90) to 211 (1991-93). This was a decrease of 61 deaths. There were substantial increases in seatbelt use in nearly all agegroups during the 1991-93 period (See Figure 7).

Males Involved in Non-Alcohol Related Fatal Crashes

Seatbelt use increased in nearly all agegroups. The only exception was in the 0-4 agegroup. An average 20 percent increase in seatbelt use was observed in the 15-19, 20-24, 25-29, and 30-34 agegroups. (See Figure 7).

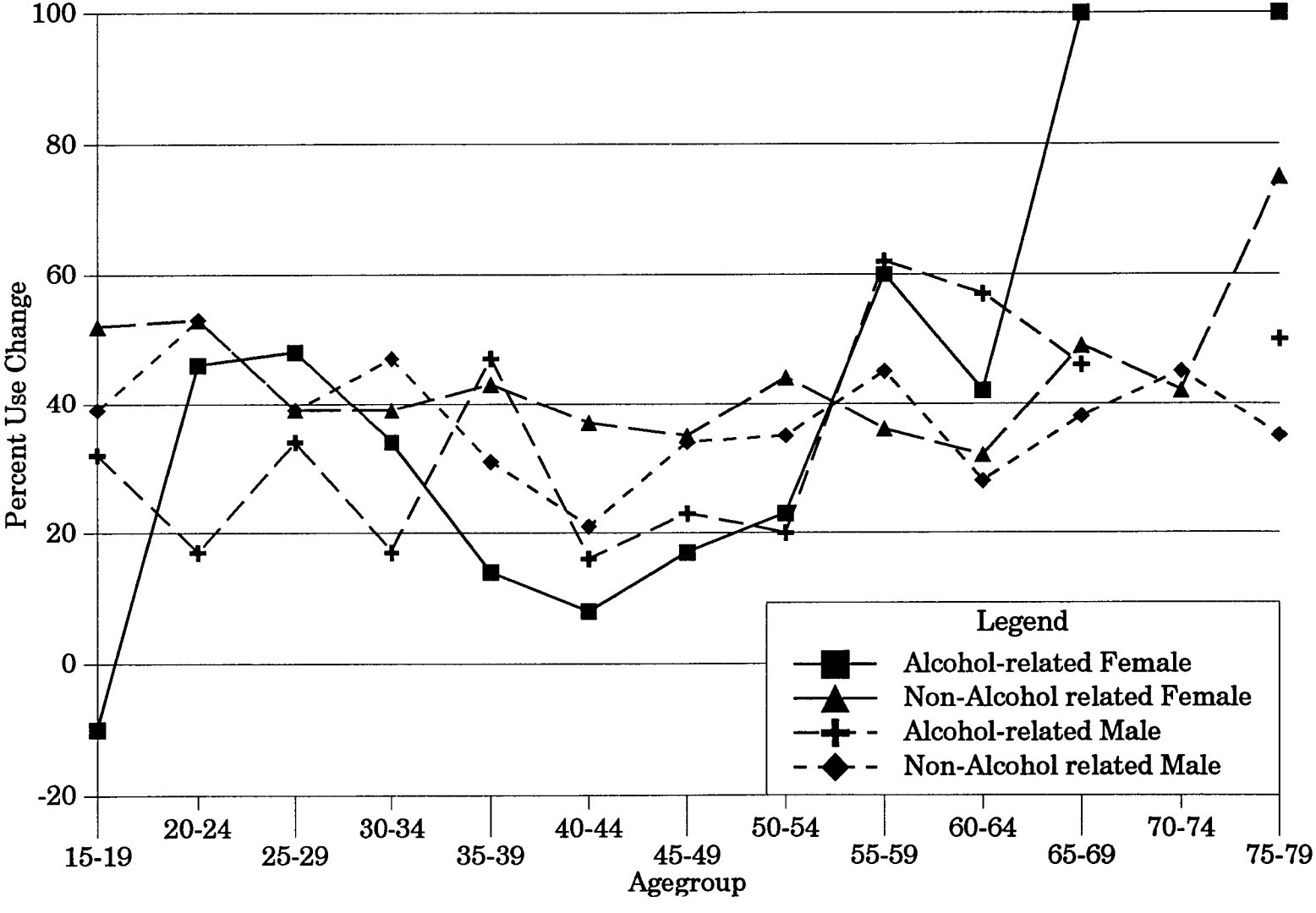
Females Involved in Alcohol-Related Fatal Crashes

Seatbelt use increased in most agegroups. However, usage dropped in the 0-4 agegroup where use dropped 80%, the 55-59 agegroup where use dropped from 25% to 20%, and the 65-69 agegroup where use dropped from 25% to 0% (See Figure 7).

Females Involved in Non-Alcohol Related Fatal Crashes

Seatbelt use increased in most agegroups. Seatbelt use dropped only in the 0-4 agegroup (child safety seats), the 35-39 agegroup, and the 45-49 agegroup.(See Figure 7).

Figure 8. Seatbelt Use Change Among Major Injured by Agegroup Gender, and Alcohol Involvement



Seatbelt Use Change Among Major Injured, By Agegroup

Males Involved in Alcohol-Related Major Injury Crashes

Seatbelt use increased among males involved in alcohol-related major injury in the 15-19 agegroup (32% increase) while numbers of injuries decreased 89% from 17 (1988-90) to 2 (1991-93). In the 20-24 agegroup, use increased 17% while major injuries decreased 60% from 42 (1988-90) to 17 (1991-93). There also was a 34% increase in seatbelt use in the 25-29 agegroup while injuries decreased 75% from 56 to 14 (See Figure 8). Although there were substantial increases in seatbelt use in every agegroup, three (15%) of the agegroups experienced increases in injury numbers during the 1991-93 period. These included the 35-39, the 45-49, and the 50-54 agegroups. However, these increased numbers of injuries were vastly overshadowed by the decrease associated with the 17 other agegroups. Overall, there was a 24% increased use of seatbelts among males involved in alcohol-related major injury crashes.

Males Involved in Non-Alcohol Related Major Injury Crashes

Seatbelt use increased consistently across all agegroups of males involved in non-alcohol relatee major injury crashes. Use more than doubled after adoption of the law among the 15-19, 20-24, 25-29, 30-34, 55-59, 70-74, 75-79, and 80-84 agegroups (See Figure 8). Overall, seatbelt use increased 38% among males involved in non-alcohol related major injury crashes.

Females Involved in Alcohol-Related Major Injury Crashes

Seatbelt use increased in all agegroups with the exception of the 15-19 agegroup where use dropped from 30% (1988-90) to 20% (1991-93). Despite this drop in use, the number of injuries in the 15-19 agegroup decreased 50% from 10 (1988-90) to 5 (1991-93). Major injuries among females involved in alcohol related crashes did increase in 3 (15%) agegroups. They include the 40 thru 44, 45 thru 49, and the 60 thru 64 agegroups (See Figure 8). Overall, there was a 31% increase in seatbelt use among females involved in alcohol-related major injury crashes.

Females Involved in Non-Alcohol Related Major Injury Crashes

Increases in seatbelt use was most impressive among non-intoxicated females where use increased consistently across all agegroups. Increased use ranged from 32% to 53% in agegroups under age 75. Major injuries decreased in most agegroups. Exceptions were found in the 45-49, 75-79, 80-84, and 85-89 agegroups.
After adoption of the law, seatbelt use among non-intoxicated females rose from an average of 44% to 91%, which represents an overall increase of 47% for females involved in non-alcohol related major injury crashes (See Figure 8).

Discussion

Seatbelt use in Oregon increased dramatically during the three year period following adoption of seatbelt legislation. This finding is consistent with similar observations in Michigan,[12] Georgia,[13] and 19 U.S. cities.[14]

Motor vehicle crash deaths and major injuries decreased following adoption of seatbelt legislation. This finding is consistent with that in Michigan[15] and in Georgia.[16] There were a total of 406 fewer fatalities in Oregon during the 1991-93 period despite an overall population growth of 10% from 2.74 million in 1988 to 3.04 million in 1993. After accounting for deaths associated with motorcycles, bicycles, pedestrians, and those where seatbelt use was unknown, a total of 266 fewer deaths occurred in motor vehicles affected by seat belt legislation during the 1991-93 period.

Among non-alcohol related fatalities, seatbelt use nearly doubled from 27% in 1988-90 to 52% in 1991-93. Among alcohol-related fatalities, seatbelt use more than tripled from 9% in 1988-90 to 30% in 1991-93. This 333% increase in use was substantially larger than that observed in the 1986 national roadside study of observed use among intoxicated drivers.[17] Lund and Wolfe reported a 70% increase in use among intoxicated drivers (from 31% to 55%) between 1973 and 1986. Despite Oregon's greater percentage of increased use, there is an inconsistency between the 30% use rate among alcohol-related fatalities and Lund and Wolfe's 55% observed use rate in 1986. A Minnesota study may offer an explanation. A dose-response relationship between increased blood alcohol content (BAC) and decreased seatbelt use among (1) drunk drivers driving with passengers, and (2) drunk passengers was observed.[18] A similar dose-response relationship, however, did not exist for intoxicated drivers who were driving alone.[18] Also observed was a threshold effect, as seatbelt use remained at 40% even at the highest levels of BAC.[18] The Minnesota study data indicates that 53% of interviewed drivers were driving alone, without passengers. Although not examined in

Oregon's data, an increase in the percentage of intoxicated drivers, driving without passengers, could account for an elevation in percent of seatbelt use.[18] Similarly, an increase in the percentage of intoxicated drivers, driving with passengers would account for a decrease in percent of seatbelt use. Figure 2. illustrates this pattern of consistent increased seatbelt use among both alcohol-related and non-alcohol related male and female motor vehicle crash fatal victims. These results suggest that reductions in deaths may be attributed to the demonstrated increase in seatbelt use.

Among non-alcohol related major injury victims, seatbelt use nearly doubled from 43.5% in 1988-90 to 85.5% in 1991-93. Among alcohol-related major injury victims, seatbelt use more than doubled from 29.5% in 1988-90 to 60.5% in 1991-93. Figure 3 illustrates this pattern of consistent increased seatbelt use among both alcohol-related and non-alcohol related male and female motor vehicle crash major injury victims. These results suggest that reductions in major injuries may be due to the demonstrated increase in seatbelt use.

Males and females involved in alcohol-related fatal crashes accounted for the largest decrease in mortality where 150 fewer fatals (117 males and 33 females) occurred during the 1991-93 period compared to 116 fewer fatals (86 males and 30 females) which occurred among non-alcohol involved males and females during the same period. The fact that mortality decreased most among alcohol-involved males and females is curious in that, although it occurred during a period when their seatbelt use tripled, their overall percentage of seatbelt use remained approximately half that of their sober counterparts. A plausible explanation is that the incidence of drunk driving has

diminished. Lund and Wolfe (1991) reported that the percent of late-night weekend drivers with BACs greater than 0.10% has decreased from 4.9% in 1973 to 3.1% in 1986. The cause, or causes, responsible for this decrease is controversial. Some credit prompt license suspension for persons who drive while intoxicated, lowering legally permissible blood alcohol content (BAC), sobriety checkpoints; public eduction, community awareness and media campaigns about the dangers of drunk driving.[7] In contrast, others found that laws requiring mandatory minimum fines or a minimum period of license revocation were not significant for reducing mortality.[19] They did find, however, that a combination of public policies which include increasing the price of alcoholic beverages and making purveyors of alcoholic beverages liable for customers drunken actions (dram shop laws), as well as policies not directly related to alcohol such as increased police protection, would provide a basis from which mortality could be reduced.[19]

The largest decrease in morbidity and mortality appeared in the 15 to 39 agegroup. Figures 5 and 6 confirms the increased percentage of seatbelt usage among all victims of this agegroup with the exception of only the 15-19 fatal alcohol-related female and 35-39 major injury non-alcohol related female. Figure 5 also indicates that female, non-alcohol related victims in the 55-69 agegroup were unaffected by adoption of seatbelt legislation. Figures 5 and 6 further further suggest that efforts to increase seatbelt use should focus not only on females in alcohol-related fatal crashes, but also on the parents of 0-4 females and 5-14 males who drive while intoxicated and fail to utilize a properly installed child safety seat or insist seatbelts be used.

The median DWI arrest rate dropped in Oregon from 41.01 per 10,000 population in 1988-90, to 35.36 per 10,000 during 1991-93 (ODOT). The Oregon Department of Transportation suggests that the incidence of DWI has been reduced through the enforcement of legislation targeting the drunk driver, similar to the programs identified by Fell, Hedlund, Vegega, and Klein (1994). However, it is important to recognize that such a decrease could also be the result of a decrease in available enforcement officers. Alcohol involvement in fatal crashes was observed to decrease only 3% during the 3-year period following adoption of the seatbelt legislation while alcohol-related major injuries decreased only 2%. However, the facts indicate that an action of major significance occurred in 1991 and continued through 1993, which caused a reduction in deaths and major injuries despite an increasing population. The cause for this should also be examined more closely in future studies.

The increases in seatbelt use and dramatic decreases in morbidity and mortality observed among alcohol-related crashes appear to be tied to the adoption of the seatbelt law. It appears that increased efforts to promote seatbelt use among both intoxicated and non-intoxicated motorists could further reduce morbidity and mortality. NHTSA's assessment that intoxicated motorists are less likely to wear seatbelts should itself be a call to action. The development and implementation of effective intervention strategies for the reduction of preventable death and injury requires careful consideration. It is clearly evident that legislative, judicial, enforcement, and social service efforts to modify the behavior of high risk portions of our population join a host of other entities that approach injury reduction through environmental modification. The injury model

presented by Haddon (1968) demonstrates the comprehensive approach required to truly reduce or prevent morbidity and mortality. Education, enforcement, and modification in design, construction, and materials used in production of automobiles, roadways, as well as an endless list of consumer products, reflect the extensive consideration our country has given, and continues to give toward preserving life.

Conclusions

This study has shown that adoption of Oregon's primary seatbelt legislation has substantially increased seatbelt use, not just among non-alcohol related crash victims, but also among alcohol-related crash victims. It appears that increased seatbelt use among alcohol-related fatal victims may have contributed to a greater reduction in mortality. It was, however, surprising to observe that a 19% increase in seatbelt use among males involved in alcohol-related fatal crashes and a 28% increase in seatbelt use among females involved in alcohol-related fatal crashes may have been associated with a greater decrease in mortality than that observed among males and females involved in non-alcohol related fatal crashes. It was also interesting to observe that alcohol-related fatalities decreased only 3% and alcohol-related morbidity only 2% during the period following Oregon's adoption of seatbelt legislation.

Although seatbelt use among motorists involved in fatal and major injury producing alcohol-related crashes has increased with the adoption of the seatbelt law, use continues to lag behind that of sober motorists. NHTSA has documented that intoxicated motorists are less likely to buckle-up and yet efforts to increase seatbelt use among intoxicated motorists are conspicuously non-existent. Perhaps there is a moral issue.

Efforts to preserve life are occasionally overshadowed by issues some people consider morally unacceptable or feel infringe upon their rights. Two of the best examples of this involves the placement of condom dispensers in high schools and the provision of new disposable syringes to intravenous drug users to prevent the spread of the human immunodeficiency virus (AIDS). Even though both intervention strategies are based on sound intervention principles, both receive substantial opposition. Similar efforts to reduce morbidity and mortality through the adoption and enforcement of laws, or codes, ie; requiring use of seatbelts, motorcycle helmets, personal flotation devices, smoke detectors, or restricting use of drugs, alcohol, and tobacco, has met with equally substantial opposition from those who consider it an infringement of personal rights. Despite controversies surrounding these issues, the "bottomline" of each is to reduce preventable morbidity and mortality. It is in this light that this study was undertaken.

For many, any message to intoxicated motorists other than "don't drink and drive" might be unacceptable. This study has, however, shown that the adoption and enforcement of legislation requiring the use of seatbelts may have had its greatest effect reducing mortality among intoxicated motorists. This implies that there may be yet another sound prevention message in addition to the standard message of "don't drink and drive". That message, "don't drink and drive ..... without fastening your seatbelt", recognizes the fact that motorists continue to drive while intoxicated. The issue is similar to that of the condom dispensers in schools and the provision of free disposable syringes to IV drug users in the prevention of AIDS. Instructing people to simply abstain from having sex and IV drug use is unlikely to produce the desired result of stopping the

spread of AIDS. Similarly, telling people not to "drink and drive" is unlikely to stop motorists from traveling while intoxicated. As condoms and new, disposable syringes are critical to prevent contracting AIDS, the use of seatbelts are critical to prevent the premature loss of life of motorists, at any age, intoxicated or sober. Although a new message will evoke controversy, it is imperative that we not loose sight of the "bottomline".

Recommendations

As available technology improves, so should efforts to reduce preventable motor vehicle crash morbidity and mortality. Increased work in broad-based educational programs which include the targetting of high-risk populations (including alcohol consuming populations) should coincide with the implementation of improved occupant protection equipment (air bags, etc.). Motor vehicles are associated with 50,000 deaths and hundreds of thousands of injuries annually. Although some may argue, this would seem to qualify motor vehicles as inherently dangerous. In that light, convenient, affordable, and dependable alternative methods of transportation (mass transit) could effectively reduce motor vehicle crash morbidity and mortality.

The following recommendations are made with regard to future studies:

1. The fact that mortality decreased most among males and females involved in alcohol-related fatalities, is curious in that, although it occurred during a period when their seatbelt use tripled, their overall percentage of seatbelt use remained approximately half that of their non-alcohol related counterparts. Identifying and quantifying potential causes for this should be considered in future studies.

2. A secondary benefit in the adoption of primary seatbelt legislation may be that motorists that continue to drive while intoxicated perceive a greater risk of arrest from non-use of seatbelts, in a primary law state, than from driving while intoxicated. This phonomena should be studied further.

3. Agencies and private organizations that work toward reductions of alcohol-related motor vehicle crash morbidity and mortality should be studied to determine what issues prevent them from targeting intoxicated motorists in seatbelt campaigns.

References

1. Karpf, R.S., and A.F. Williams . Teenage drivers and motor vehicle deaths. *Accident Analysis and Prevention.* 1983;15:5-63.

2. Rice, DP; EJ MacKenzie, and Associates, *Cost of Injury in the United States: A Report to Congress.* San Fransisco: Institute for Health and Aging, University of California and Injury Prevention Center, The Johns Hopkins University. 1989.

3. Sosin, DM; JJ Sacks, and SM Smith. Head Injury Associated Deaths in the United States from 1979 to 1986. *JAMA* 1989;262:2251-2255.

4. Kraus, JF; CE Franti; RS Riggins, D Richards, and NO Borhani. Incidence of Traumatic Spinal Cord Lesions. *Journal of Chronic Diseases.* 1975;28:471-492.

5. Karlson, TA. The Incidence of Hospital Treated Facial Injuries from Vehicles. Journal of Trauma. 1982;22:303-310.

6. Robertson, LS. *Injuries: Causes, Control Strategies, and Public Policy.* Lexington, MA: Lexington Books. 1983.

7. Fell, JC; Hedlund, J: Vegega, ME; Klein, TM; and Johnson, D. Reduction in alcohol-related traffic fatalities-United States, 1990-1992. JAMA. 1994;27:100.

8. Oregon Department of Transportation, Transportation Safety Section. Fatal Accident Reporting System (FARS). Fatalities between 1988-1993. (Computer files).

9. Oregon Department of Transportation, Transportation Safety Section. Major injury data in the State of Oregon. Major injuires between 1988-1993. (Computer files).

10. Oregon Department of Transportation, Transportation Safety Section. Definition of injuries in the State of Oregon.

11. Oregon Department of Transportation. DWI control system performance measures for Oregon counties. 1992-1993. 1994.

12. Wagenaar, A.; Wiviott, M. Effects of mandating seatbelt use: a series of surveys on compliance in Michigan. Public Health Reports. 1986;101:505-513.

13. Martin, J.K., Kingery, D.W., Shinholser, K.J., and Helms-Nelson. K. State-wide use of occupant restraints: Self-report and observational surveys of safety restraint use in Georgia. Athens, GA: University of Georgia, Survey Research Center. 1991.

14. Datta, T.K., Guzek, P. Restraint system use in 19 U.S. cities: 1989 Annual Report. Washington, DC: US Department of Transportation; 1990.

15. Wagenaar, A.; Wiviott, M. Effects of mandating seatbelt use: a series of surveys on compliance in Michigan. Public Health Reports. 1986;101:505-513.

16. Thyer, B.A.; Robertson, M. An initial evaluation of the Georgia safety belt use law. Environment and Behavior. 1993;5:506-513.

17. Lund, A.K.; and A.C. Wolfe. Changes in the incidence of alcohol-impaired driving in the United States, 1973-1986. Journal of Studies on Alcohol. 1991;52:293-301.

18. Foss, R.D.; Beirness, D.J.; Sprattler K. Seatbelt use among drinking drivers in Minnesota. American Journal of Public Health. 1994;84:1732-1737.

19. Sloan, F.A.; Reilly, B.A.; Schenzler, C. Effects of prices, civil and criminal sanctions, and law enforcement on alcohol-related mortality. Journal of Studies on Alcohol. 1994;55: 454-465.

BIBLIOGRAPHY

Baker, S.P.; O'Neill, B.; Ginsburg, M.J.; Li G. The Injury Fact Book, Second Edition. Oxford Press 1992.

Datta, T.K., Guzek, P. Restraint system use in 19 U.S. cities: 1989 Annual Report. Washington, DC: US Department of Transportation; 1990.

Fell, JC; Hedlund, J: Vegega, ME; Klein, TM; and Johnson, D. Reduction in alcohol-related traffic fatalities-United States, 1990-1992. JAMA. 1994;27:100.

Foss, R.D.; Beirness, D.J.; Sprattler K. Seatbelt use among drinking drivers in Minnesota. American Journal of Public Health. 1994;84:1732-1737.

Jacobs, James. Drunk Driving. Chicago: University of Chicago Press 1989.

Karlson, TA. The incidence of hospital treated facial injuries from vehicles. Journal of Trauma. 1982;22:303-310.

Karpf, R.S., and A.F. Williams. Teenage drivers and motor vehicle deaths. Accident Analysis and Prevention . 1983;15:5-63.

Klein, T.M., Burgess, M. Alcohol involvement in fatal crashes - 1992. Washington, DC: National Highway Traffic Safety Administration; 1994.

Kraus, JF; CE Franti; RS Riggins, D Richards, and NO Borhani. Incidence of traumatic spinal cord lesions. Journal of Chronic Diseases. 1975;28:471-492.

Lund, A.K.; and A.C. Wolfe. Changes in the incidence of alcohol-impaired driving in the United States, 1973-1986. Journal of Studies on Alcohol. 1991;52:293-301.

Martin, J.K., Kingery, D.W., Shinholser, K.J., and Helms-Nelson. K. State-wide use of occupant restraints: Self-report and observational surveys of safety restraint use in Georgia. Athens, GA: University of Georgia, Survey Research Center. 1991

Moskowitz, H., Burns, M.M. and Williams, A.F. Skills performance at low blood alcohol levels. Journal of Studies on Alcohol. 1985;46:482-485.

National Highway Traffic Safety Administration. NHTSA Technical Report: Alcohol Involvement in Fatal Traffic Crashes 1993. 1995;Publication No. DOT HS 808 289.

National Highway Traffic Safety Administration. Traffic Tech. NHTSA Technology Transfer Series, 1996;117. U.S. Department of Transportation.

Oregon Department of Transportation. DWI control system performance measures for Oregon counties. 1992-1993. 1994.

Oregon Department of Transportation. Highway safety plan, fiscal year 1995. Transportation Safety Section.

Oregon Department of Transportation. Oregon safety belt legislation history, 1996. Transportation Safety Section.

Oregon Health Division. Oregon Trauma System Biennial Report 1991-1992. Emergency Medical Services and Systems.

Rice, DP; EJ MacKenzie, and Associates. Cost of Injury in the United States: A Report to Congress. San Fransisco: Institute for Health and Aging, University of California and Injury Prevention Center, The Johns Hopkins University. 1989.

Robertson, LS. Injuries: Causes, Control Strategies, and Public Policy. Lexington, MA: Lexington Books. 1983.

Robertson, LS. Reducing death on the road: The effects of minimum safety standards, publicized crash tests, seat belts, and alcohol. American Journal of Public Health. 1996;86:31-34.

Sloan, F.A.; Reilly, B.A.; Schenzler, C. Effects of prices, civil and criminal sanctions, and law enforcement on alcohol-related mortality. Journal of Studies on Alcohol. 1994;55: 454-465.

Sosin, DM; JJ Sacks, and SM Smith. Head injury associated deaths in the United States from 1979 to 1986. JAMA. 1989;262:2251-2255.

Thyer, B.A.; Robertson, M. An initial evaluation of the Georgia safety belt use law. Environment and Behavior. 1993;5:506-513.

Wagenaar, A.; Margolis, L. Effects of mandatory safety belt laws on hospital admissions. Accid Anal Prev. 1990;22:253-262.

Wagenaar, A.; Wiviott, M. Effects of mandating seatbelt use: a series of surveys on compliance in Michigan. Public Health Reports. 1986;101:505-513.

Winn, Russell and David Giacopassi. Effects of county-level alcohol prohibition on motor vehicle accidents. Social Science Quarterly, 1993;74:783-792.

Zador, P.L. Alcohol-related relative risk of fatal driver injuries in relation to driver age and sex. *Journal of Studies on Alcohol.* 1991;52:302-310.

APPENDIX

Figure 1. Seatbelt Use Among Fatally Injured by Gender, Alcohol Involvement, and Time Period.

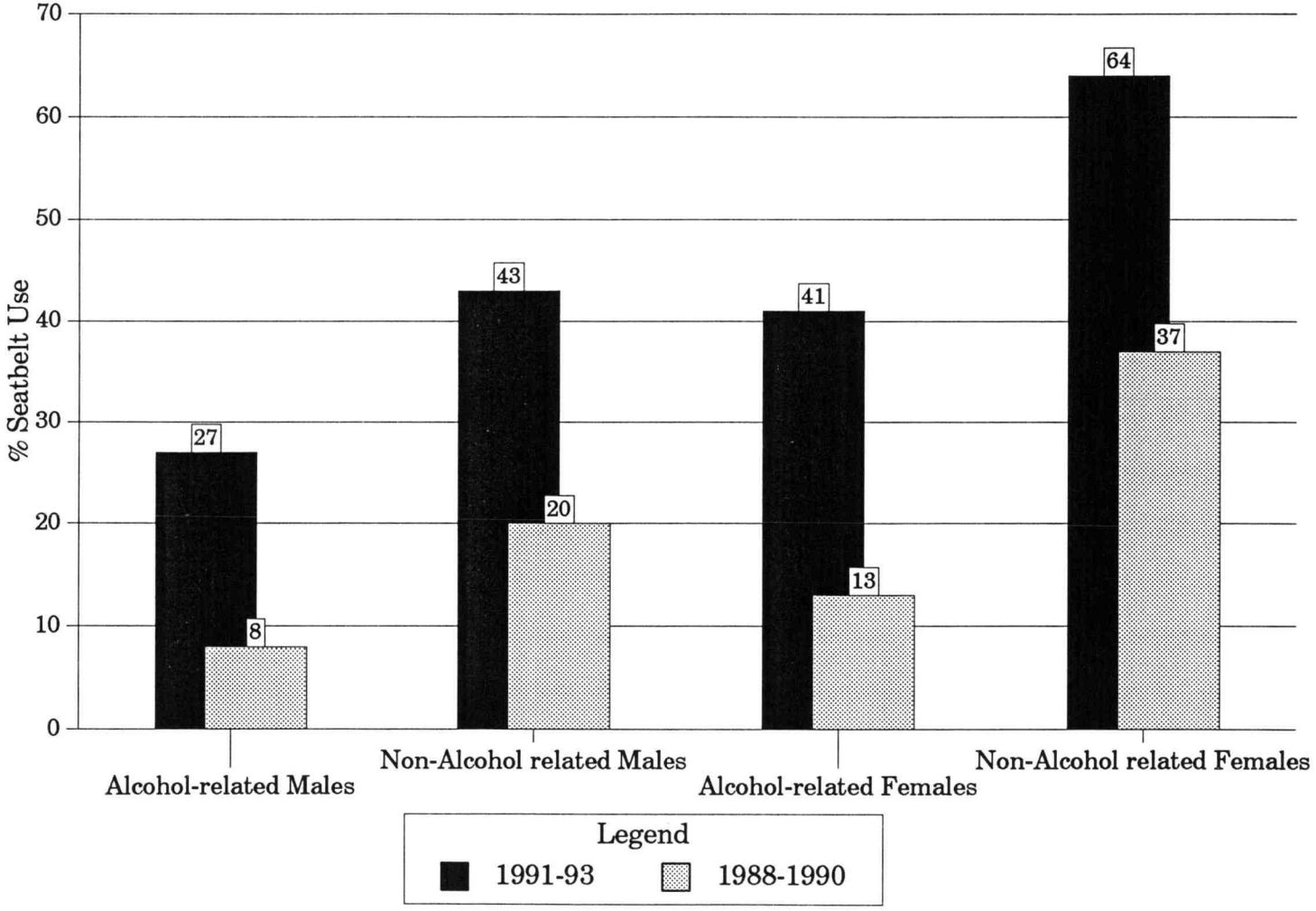


Figure 2. Seatbelt Use Among Major Injured by Gender, Alcohol Involvment, and Time Period.

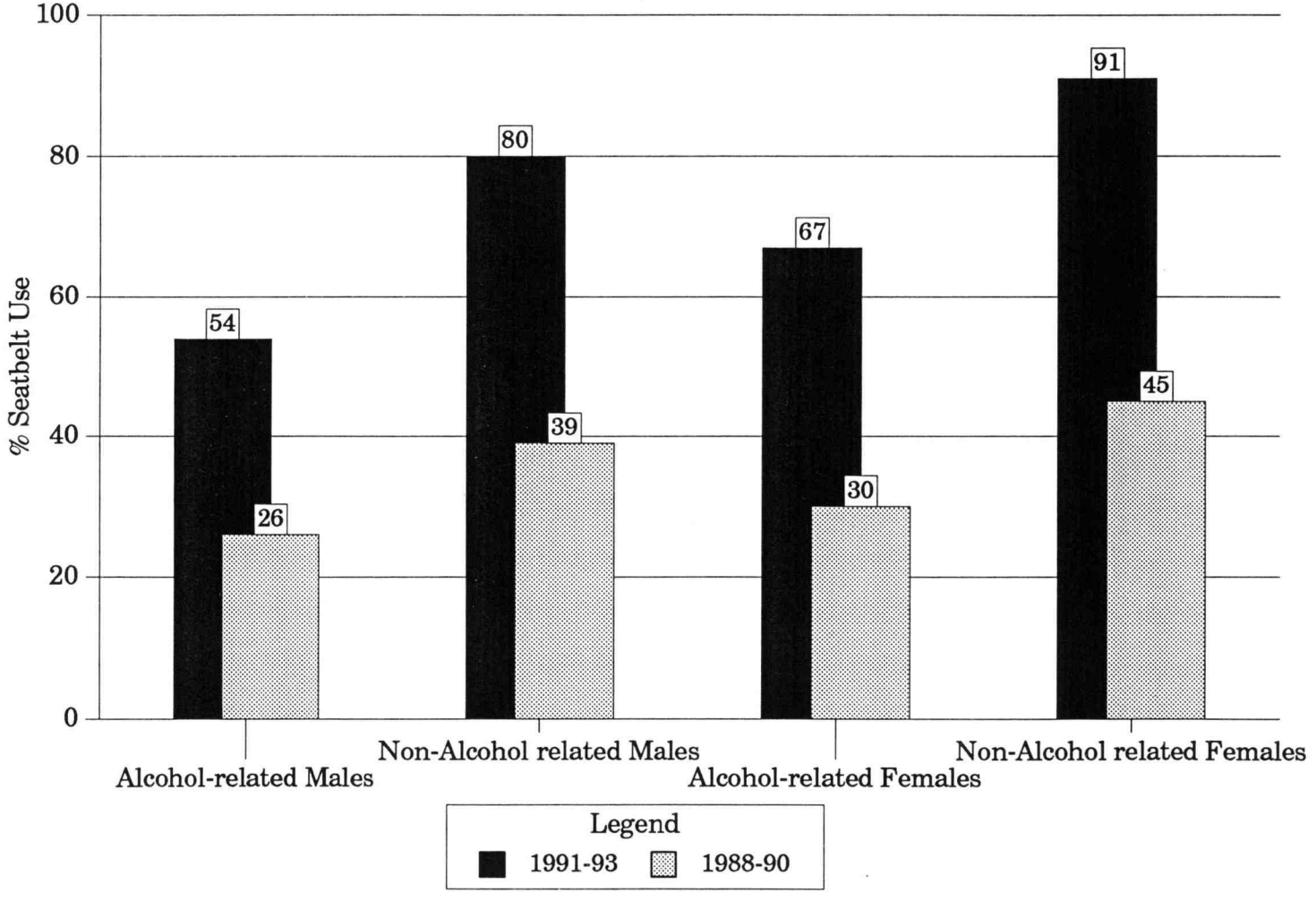


Figure 3. Seatbelt Use Among Males
Alcohol-Related Fatalities: By Agegroup and Time Period.

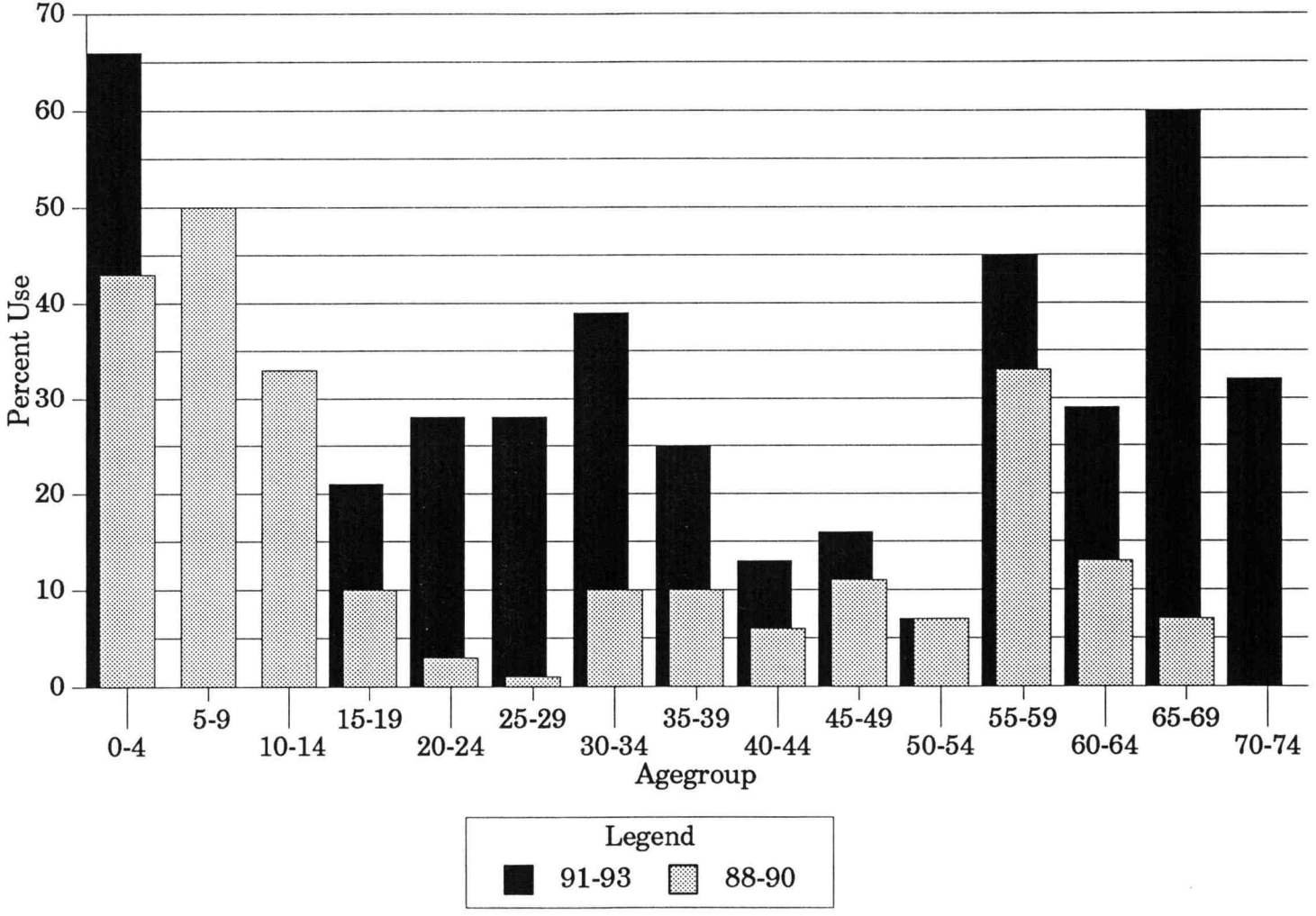


Figure 4. Seatbelt Use Among Females
Alcohol-Related Fatalities: By Agegroup and Time Period.

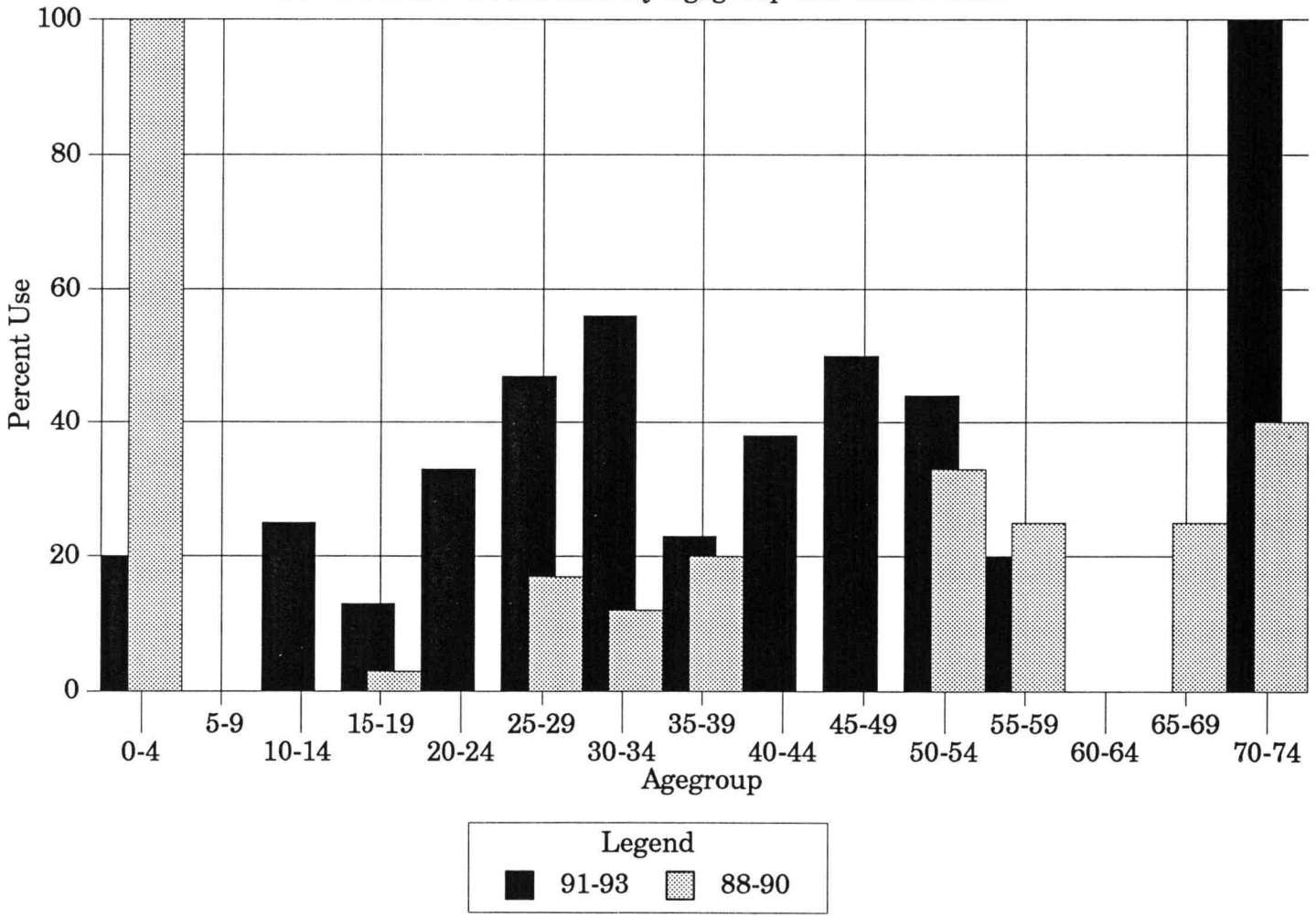


Figure 5. Seatbelt Use Among Males
In Alcohol-Related Major Injury: By Agegroup and Time Period.

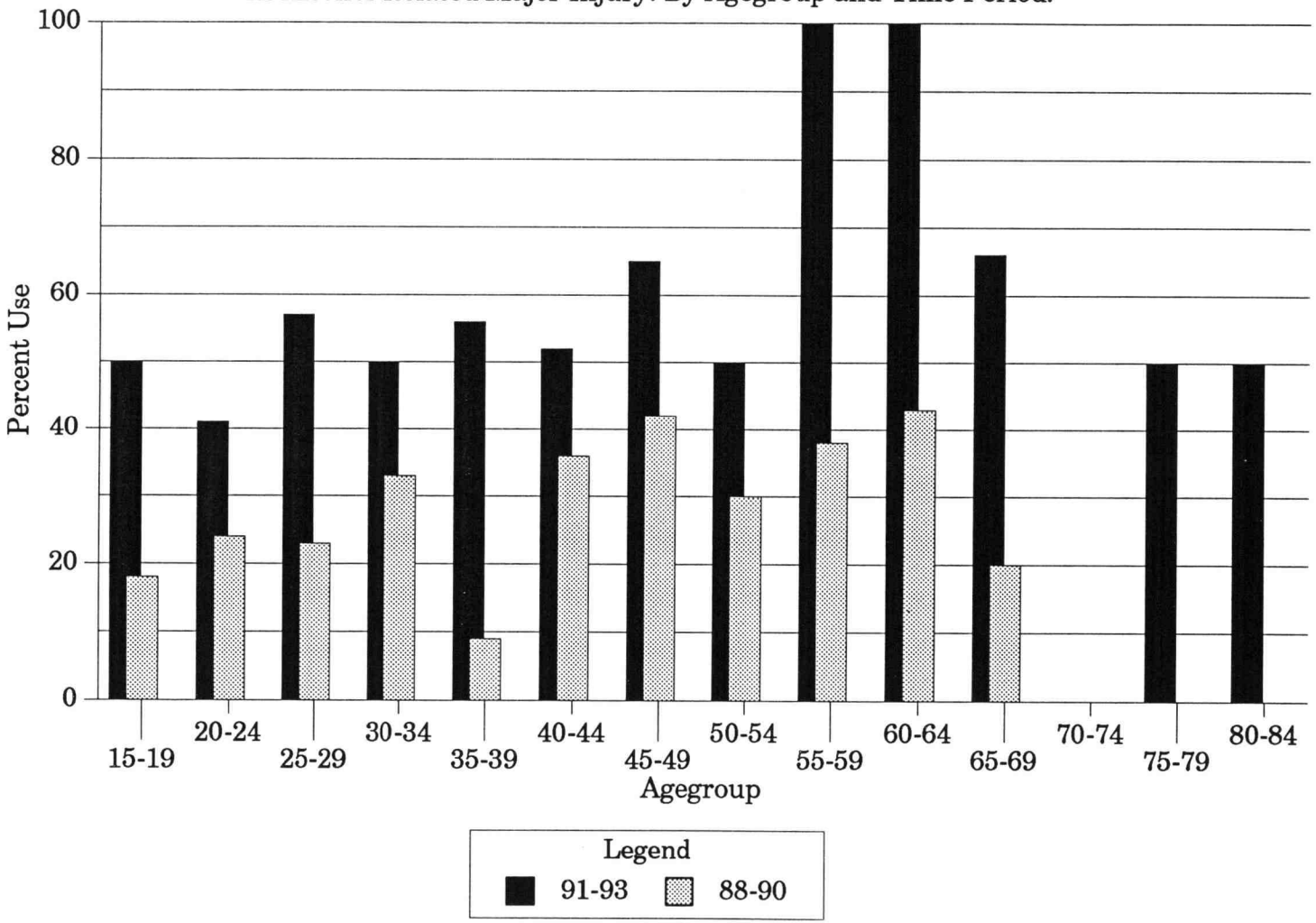


Figure 6. Seatbelt Use Among Females
Alcohol-Related Major Injury: By Agegroup and Time Period.

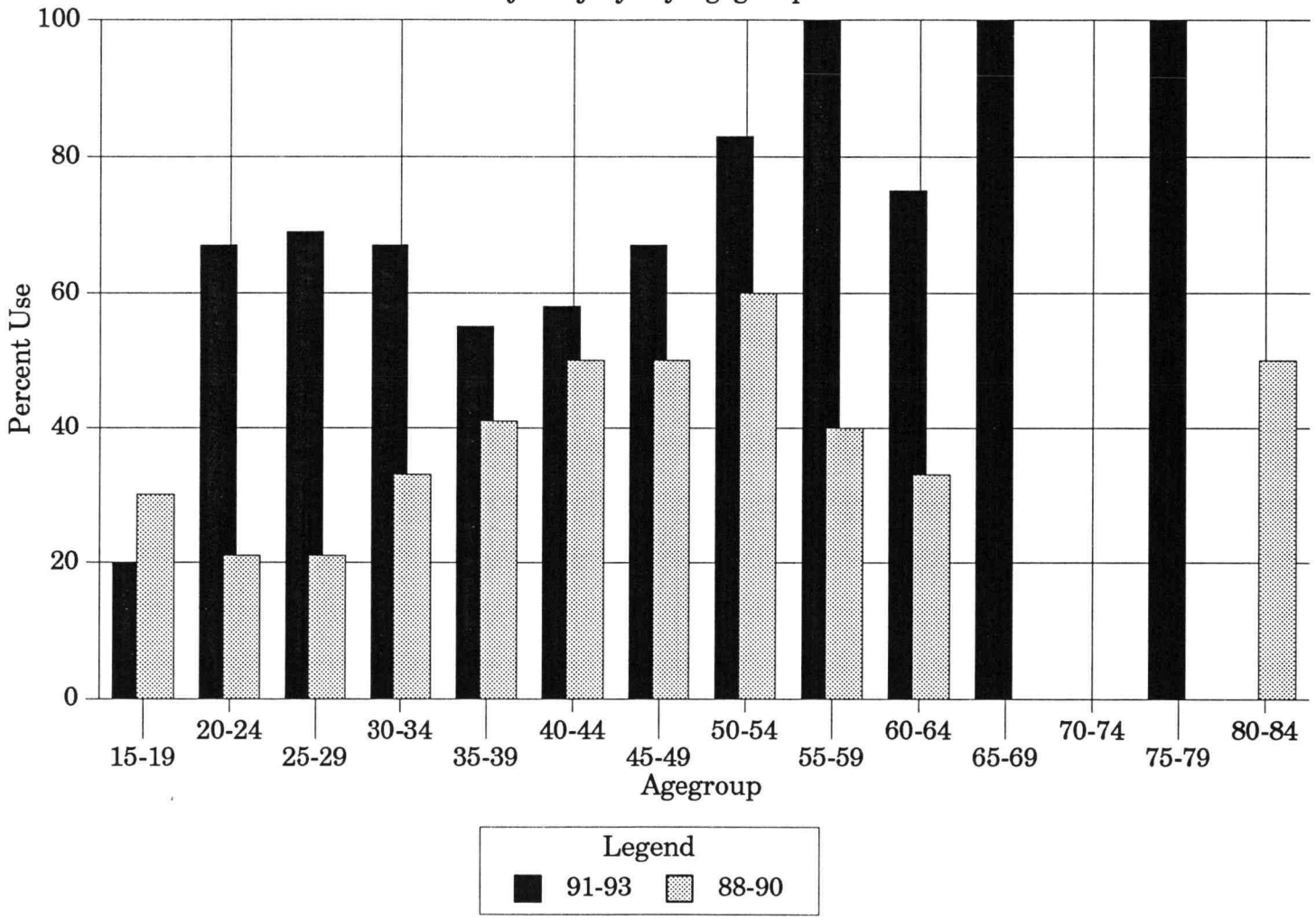


Figure 7. Seatbelt Use Among Males
Non-Alcohol Related Major Injury: By Agegroup and Time Period.

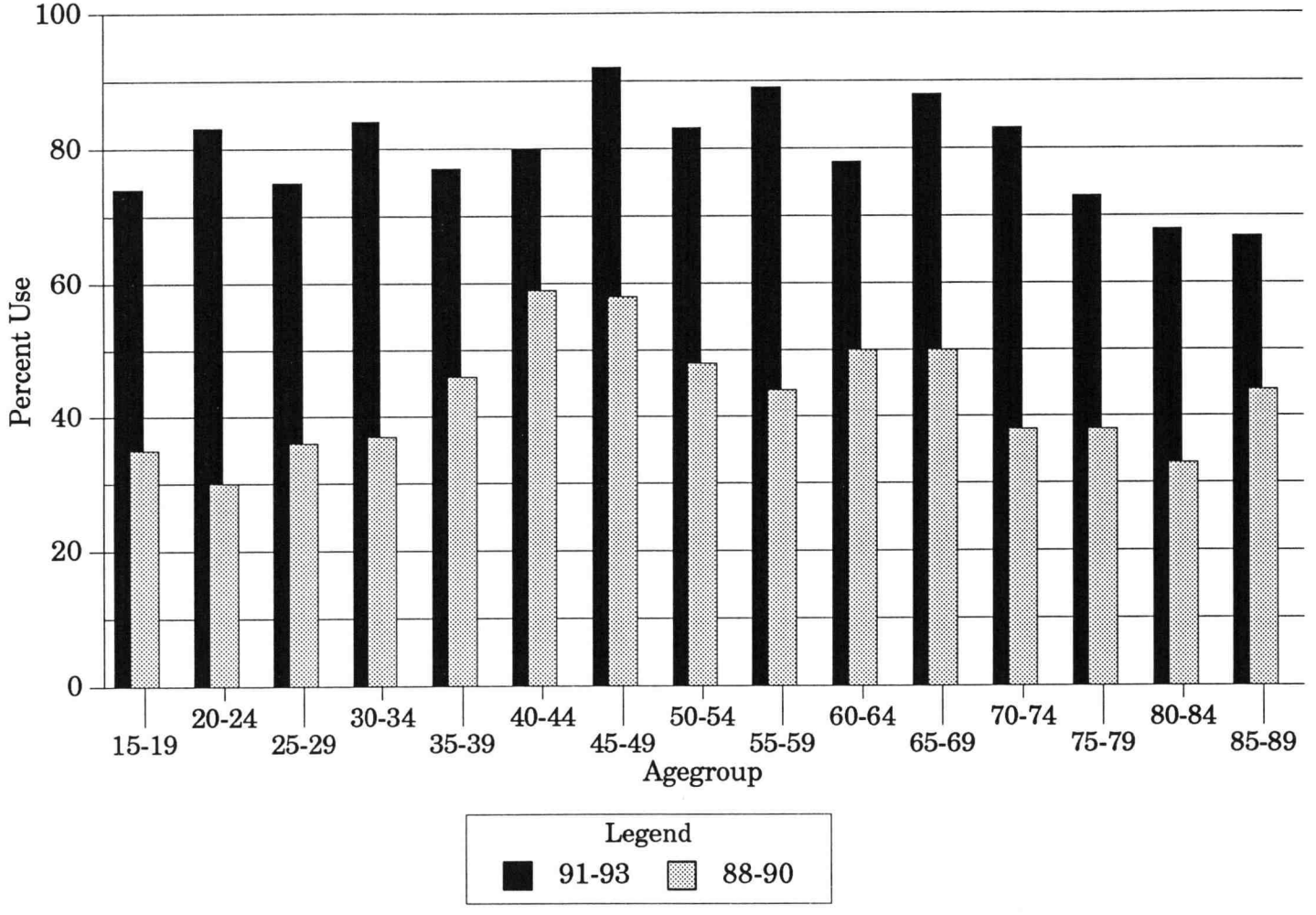


Figure 8. Seatbelt Use Among Females
Non-Alcohol Related Major Injury: By Agegroup and Time Period.