to reduce the anticipated decline for the immediate future.

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Use of Safety Belts in Kentucky

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The use and effectiveness of safety belts in Kentucky are examined, and factors that affect their use are identified. Data were obtained from three sources: field observations, accident reports, and a questionnaire. Kentucky drivers and passengers were found to have lower rates of safety-belt use (slightly less than 10 percent) than drivers and passengers in other states. The accident data showed that safety belts reduced the chance of being killed by a factor of six and the chance of being severely injured by a factor of two. Several factors were found to have significant effects on the use of safety belts. Safety-belt use was higher among drivers who were over 25 years of age, those who had a college

education, and those driving in newer and/or out-of-state automobiles, on Interstates and parkways, and in large cities. The driving records of drivers who wore safety belts were found to be better than the records of those who did not wear safety belts. In regard to a law making the use of safety belts mandatory, it was found that approximately one-third of the drivers were in favor, one-third were neutral, and one-third were against such a law.

This paper examines the incidence and effectiveness of the use of safety belts among Kentucky motorists and identifies the factors that affect safety-belt use. The feasibility of legislating the mandatory use of safety belts is also investigated.

In a 1975 study that involved only 1975-model automobiles (1), 27 percent of the drivers used a combination of lap-and-shoulder belts and an additional 1 percent used only lap belts. That study gave an estimate made by the National Highway Traffic Safety Administration (NHTSA) of 15 percent use of the lap-and-shoulder-belt combination and an additional 5 percent use of lap belts in 1975 automobiles. The opinion of NHTSA was that this was a well-based estimate when apportioned over the lifetime of the automobile.

The effectiveness of safety belts has been established. In a 1974 Kentucky study (2), it was found that a vehicle occupant who did not wear a safety belt had approximately twice the probability of being injured and four times the probability of being killed in an accident as a person who did wear a safety belt. In a 1975 report by Consumer Reports that evaluated crashes of 1973 and 1974 domestic automobiles (3), occupants who wore only a lap belt suffered severe or fatal injuries one-third less frequently than those who wore no belt at all. The use of a lap-and-shoulder harness reduced the frequency of severe or fatal injuries by one-half. Another study of crashes that involved 1973-, 1974-, and 1975-model American automobiles (3) found nonuse of safety belts in about 60 percent of the crashes. Analysis of serious injuries in these crashes showed that the use of lap-and-shoulder harnesses prevented injuries in 42 percent of the cases whereas the use of lap belts alone prevented injuries in 27 percent of the cases. It was estimated that restraint devices reduced fatalities by 61 percent.

The relation between the use of restraint systems and various other factors has been studied. A study of drivers in 1975 automobiles (1) showed that, a few months after they purchased their automobiles, only one-third of them were using shoulder belts. The use of safety belts tends to decline by 2-4 percent each year of automobile life. Passengers were found to be less likely to use safety belts than drivers and children to be less likely to use them than other passengers. Safety belts were used considerably less in small towns than in large cities.

In another study (4), an attempt was made to identify attitudinal and cognitive variables related to safety-belt use. Five factors that affect the use of safety belts by drivers were identified: discomfort, worry, risk, effectiveness, and inconvenience. The discomfort factor was related to people's feelings of comfort or discomfort when wearing a safety belt (some people have a deep-rooted aversion to being constrained whereas others feel more secure). The worry factor concerned the driver's inclination to worry or not worry about being involved or injured in a crash. The risk factor related to how much risk of accident an individual felt when driving, the effectiveness factor to the individual's feeling about the effectiveness of safety belts, and the inconvenience factor to the amount of inconvenience the person felt when fastening or unfastening a safety belt.

Discomfort was found to be the best single predictor of safety-belt use. Inconvenience rated second, but the addition of the inconvenience factor to the discomfort factor did not improve the prediction because of a high intercorrelation between those two factors. Worry and risk both had very weak relations to safety-belt use; there was a somewhat higher correlation between the effect factor and safety-belt use.

Legislation to require the use of safety belts has been suggested as a method to induce motorists to use restraint devices. Nineteen foreign countries now have laws that require the use of safety belts (5): Great Britain, France, Australia, Canada (Ontario and Quebec), Switzerland, Belgium, the Netherlands, Czechoslovakia, Sweden, Spain, Finland, Norway, Denmark, Yugoslavia, New Zealand, Israel, Luxembourg, West Germany, and the Soviet Union.

Puerto Rico was the first major political unit of the United States to adopt a safety-belt law (6). The law became effective January 1, 1974, and applies to almost everyone who rides in a vehicle that is equipped with safety belts. Persons exempted include those with medical or physical problems, those who have "occupational reasons", children for whom the use of a safety belt would constitute a risk to their person, and delivery personnel when the speed of the vehicle between stops does not exceed 24 km/h (15 miles/h).

The federal government has taken an active role in promoting safety-belt legislation. In a U.S. Department of Transportation report to Congress in 1976 (7), major highway safety countermeasures were identified and the cost-effectiveness of each was evaluated. Adoption of safety-belt laws was identified as the most cost-effective measure by which to forestall highway fatalities. The cost per fatality averted would be $506. This compares with a cost of $20 000/averted fatality for enforcement of the nationwide 88.5-km/h (55-mile/h) speed limit.

A major incentive to the enactment of safety-belt legislation by the states was the Federal-Aid Highway Act of 1973. Under incentive grants (8), states could have increased their federal highway safety money by 10, 15, or 25 percent, respectively, if they enacted legislation that would require (a) use of lap belts by all front-seat occupants, (b) use of all available safety belts by all front-seat occupants or use of lap belts by all front- and rear-seat occupants, or (c) use of all available belts by all occupants.

Although there are considerable data to support the enactment of a safety-belt law, the principal argument that must be settled is whether or not such a regulation infringes on the individual's rights. A safety-belt law may face constitutional challenges under the concepts of due process, equal protection, and right to privacy (9). The constitutional question of due process is dealt with by the precedent of laws that require motorcyclists to wear helmets. Every driver is a potential agent of death or injury to self and others. A safety belt keeps the driver behind the wheel after the first impact and aids him or her in retaining control of the vehicle while avoiding secondary impacts with other vehicles, thus reducing the potential of death and injury. The challenge of equal protection has been found to be defendable only when the statute applied to occupants of vehicles that had safety belts as standard equipment. The third argument, right to privacy, has been answered by stating that the use of highways would hardly appear to fall within the constitutionally protected zone of "privacy".

DATA COLLECTION PROCEDURE

Data were obtained from three sources. Accident data came from a computer tape of all accidents reported in Kentucky in 1976. The safety restraints used were coded

for each occupant involved in a reported accident. The use of safety belts was defined as wearing a lap belt with or without a shoulder strap.

A survey of safety-belt use was conducted, and data were collected in both urban and rural areas. Observers positioned themselves so that they could observe the use of safety belts by all occupants of stopped vehicles. Observations of more than 7000 vehicle occupants were recorded, as indicated below:

Location	Number of Observations	
	All Occupants	Drivers
Urban area		
Large	3205	2215
Small	1431	970
Rural area		
Interstate and parkway	1531	823
Two-lane	1151	693
Total	7318	4701

A questionnaire was sent to randomly selected licensed drivers and was given to drivers who attended driver-improvement clinics. The questionnaire was part of a study that dealt with the general characteristics of Kentucky drivers, but a number of the questions related specifically to safety-belt use. Of 3000 questionnaires mailed, 1465 (or 49 percent) were returned. The sample was representative of the driving population in the following areas:

1. The driving population consists of 56 percent males and 44 percent females. The questionnaire sample consisted of 57 percent males and 43 percent females.
2. The age distribution of the driving population is 24 percent under the age of 25, 48 percent between the ages of 25 and 49, and 28 percent 50 years of age or older. In the questionnaire sample, the percentages for these categories were 21, 49, and 30 percent, respectively.

The number of questionnaires completed at driver-improvement clinics was 931. Most of the analyses used only the randomly selected drivers, but summaries from the driver-improvement clinics were used for comparison in some instances.

RESULTS

Safety-Belt Use

Safety-belt use was determined from three sources: field observations, accident data, and questionnaires. As expected, the rates obtained from the questionnaire survey were higher than those obtained from the other sources since people tend to overestimate their use of safety belts. In general, the data showed that Kentucky drivers and passengers use safety belts less than people in other states. The accident data obtained are given below:

Age (years)	Percentage Using Safety Belt			
	All Occupants		Drivers	
	Male	Female	Male	Female
1-2	6.1	6.1		
3-5	3.4	3.2		
6-12	3.1	2.9		
13-15	2.5	2.4		
16-19	4.6	5.0	5.7	6.6
20-24	7.1	7.4	7.8	8.6
25-29	10.4	8.7	11.3	9.5
30-39	10.3	8.1	11.0	8.6
40-49	9.6	8.4	10.1	9.6
50-59	10.2	10.0	10.7	11.9
60-69	8.8	8.8	9.3	10.4
70 or older	7.2	7.6	7.5	9.5
Total	7.7	7.0	9.0	9.0

These data show that 9.0 percent of drivers and 7.4 percent of all vehicle occupants who were involved in accidents were wearing safety belts. Rates of more than 20 percent have been reported by other researchers (1, 10-13).

Field observations were made at various types of locations, and safety-belt use varied according to location (see Table 1). By obtaining the percentage of vehicle distance traveled for each type of highway and comparing it with total vehicle distance traveled in the state, a single usage rate was obtained. The overall usage rates from field observations were 8.7 percent for drivers and 7.3 percent for all vehicle occupants. These percentages are very close to the corresponding usage rates found above from the accident data.

When both accident data and observations were considered, several factors that affect usage rates could be seen:

1. The use of safety belts was highest on Interstates and parkways and lowest on rural, two-lane roads; in urban areas it was between the two extremes.
2. Safety-belt use was higher in newer-model and out-of-state automobiles.
3. Drivers used safety belts much more than passengers, and very few rear-seat passengers used them.
4. There was no significant difference between the usage rates of males and females.
5. Rates of safety-belt use among children were very low. For adults, the rate tended to increase for both drivers and all occupants over 25 years of age and then to decrease for people over 70 years of age.

In the questionnaire, drivers were asked to indicate how often they used safety belts. They were given four choices of answers: always, most of the time, occasionally, and never. For purposes of comparison, it was decided to use the percentage of respondents who answered either "always" or "most of the time" to approximate the reported use of safety belts.

The reported safety-belt use of high-risk drivers (drivers who were attending driver-improvement clinics) was 18 percent—less than that for the population at large, which was 25 percent. High-risk drivers reported that, as passengers, they used safety belts 16 percent of the time compared with 20 percent for the population at large.

During field observations, the use of a lap belt only versus a lap-and-shoulder combination was recorded (see Table 2). Among all occupants, use of lap-and-shoulder harnesses was greater than use of lap belts only. The difference was particularly pronounced among occupants of out-of-state automobiles. Usage varied with vehicle age. Occupants of newer automobiles used both lap belts and shoulder belts more often. This, of course, is related to older automobiles not being equipped with shoulder belts.

The rate of safety-belt use among passengers was found to relate strongly to whether the driver was using a safety belt. In field observations, it was found that only 2 percent of the passengers fastened their safety belts when the driver had not fastened his or hers but

Table 1. Results of field observations of safety-belt use.

Variable	Category	Drivers Wearing Lap Belt or Shoulder Belt (%)	Occupants Using Lap Belt Only (%)	Occupants Using Lap Belt and Shoulder Belt (%)
Location	Urban area			
	Large	12	5	5
	Small	11	4	4
	Rural area			
	Interstate and parkway	13	5	7
	Two-lane	5	1	3
Age of vehicle	Pre-1966	4	3	0
	1966-1971	8	5	2
	1972 to present	13	4	6
Residence	Kentucky	10	4	4
	Out of state	16	3	11
Position of occupant in vehicle	Driver		5	6
	Passenger			
	Front seat		2	4
	Rear seat		1	0
	All positions		4	5
Sex	Male	10	4	5
	Female	13	4	5
Age of occupant	Child (1-9 years)		3	0
	Pre-adult (10-15 years)			
	Adult		1	3
	16-30 years	11	4	5
	31-60 years	10	4	5
	≥ 61 years	12	4	4

Table 2. Type and severity of injuries associated with safety-belt use.

Category	Type of Injury				
	Fatal	Type A (incapacitating)	Type B (nonincapacitating)	Type C (possible injury)	Type A plus Type B
Percentage not wearing safety belt					
All occupants	0.23	2.25	4.89	5.42	7.14
Driver	0.24	1.95	4.27	4.59	6.22
Passenger					
Front seat	0.24	3.23	6.78	7.88	10.01
Rear seat	0.21	2.40	5.59	6.19	7.99
Percentage wearing safety belt					
All occupants	0.04	1.15	3.71	5.41	4.86
Driver	0.02	1.06	3.48	4.75	4.54
Passenger					
Front seat	0.14	1.89	5.21	9.37	7.10
Rear seat	0	0.84	4.41	7.13	5.25
Percentage of drivers not wearing safety belt					
Rural	0.37	2.78	5.71	5.67	8.49
Interstate and parkway	0.48	2.85	5.17	5.59	8.02
Urban	0.05	0.83	2.32	3.05	3.15
Percentage of drivers wearing safety belt					
Rural	0.04	1.56	5.24	6.00	6.80
Interstate and parkway	0.05	0.99	2.98	4.45	3.97
Urban	0	0.66	2.15	3.81	2.81
Percentage of all occupants injured wearing safety belt[a]	1.2	3.9	5.7	7.4	9.6
Ratio of safety-belt use for all occupants[b]	6.2	1.9	1.3	1.0	1.5

[a] Wearing lap belt with or without shoulder harness.
[b] Ratio of percentage of all occupants wearing safety belts to percentage of use in each injury classification.

Table 3. Injury severity in relation to part of vehicle damaged.

Safety-Belt Use	Type of Injury	Percentage of Accidents by Part of Automobile Damaged			
		Front	Rear	Side	Top
Not wearing	Fatal	0.31	0.04	0.33	1.74
	A	3.14	0.75	2.15	7.59
	B	6.68	2.15	4.61	20.00
	C	6.23	5.85	4.87	13.30
Wearing	Fatal	0.06	0.02	0	0
	A	1.51	0.43	1.38	5.38
	B	4.71	2.04	3.37	16.20
	C	5.64	5.87	3.97	9.23

that this increased to 47 percent when the driver was using a safety belt. This leads to the conclusion that, if drivers could be induced to use safety belts, the usage rates of passengers would significantly increase. The highest incidence in any category was 22 percent among drivers of new (1973 to the present), out-of-state vehicles on Interstates and parkways.

Accident Severity

Accident severity was related to safety-belt use (injuries involving pedestrians, motorcycles, farm equipment, and bicycles were excluded from the analysis). The percentage of occupants in each injury classification who were wearing a safety belt was calculated (Table 2), and this was related to the total percentage of occupants who wore safety belts (7.4 percent). If safety belts had no effect on minimizing injuries, the rate of use would be 7.4 percent for each type of injury. However, the percentage of occupants who were killed while wearing a safety belt was only 1.2 percent, and the percentage of

Table 4. Bodily injuries sustained by drivers.

Injury	Percentage of Total Injuries			
	Pre-1974 Vehicles		1974-1977 Vehicles	
	Not Wearing Safety Belt	Wearing Safety Belt[a]	Not Wearing Safety Belt	Wearing Safety Belt[b]
Head and face	46.7	40.5	47.2	36.0
Neck	8.8	14.1	9.6	13.9
Chest	6.4	5.7	5.8	5.6
Back	7.9	8.4	7.0	11.2
Abdomen and pelvis	2.4	2.9	2.0	2.5
Arms and hands	9.7	10.4	9.7	11.0
Legs and feet	10.9	13.8	12.3	14.0
Multiple, entire body	7.2	4.2	6.4	5.8

[a] Primarily lap belt only.
[b] Primarily lap belt and shoulder belt.

Table 5. Safety-belt use by all vehicle occupants in relation to variables that affect usage.

Variable	Category	Percentage Wearing Safety Belts[a]	Variable	Category	Percentage Wearing Safety Belts[a]
Sex	Male	7.7	Time of day	12 m.n. -3 a.m.	6.6
	Female	7.0		12 n. -3 p.m.	6.7
Age (years)	<6	4.6		6-9 a. m.	8.3
	6-12	2.9		9 a. m. -12 n.	7.0
	13-15	2.4		12 n. -3 p.m.	7.1
	16-24	5.6		3-6 p. m.	8.0
	25-49	8.7		6-9 p. m.	7.5
	≥ 50	8.4		9 p. m. -12 m.n.	7.1
Occupant position in vehicle	Driver	9.1	Day of week	Sunday	6.3
	Passenger			Monday	7.5
	Front seat	4.4		Tuesday	8.1
	Rear seat	2.5		Wednesday	8.0
Highway type of accident site	State or federal	5.8		Thursday	7.5
	County or local	4.7		Friday	7.5
	Interstate or parkway	18.7		Saturday	6.7
	Local street	8.7	Month	January	8.4
Vehicle age	Pre-1966	6.5		February	7.7
	1966-1971	6.1		March	8.7
	1972 to present	11.6		April	8.0
Population of city of accident site	<2500 (rural)	6.1		May	7.5
	2500-10 000	3.4		June	7.4
	10 001-25 000	5.1		July	6.9
	25 001-50 000	3.3		August	6.5
	50 001-100 000	5.1		September	7.0
	100 001-250 000	14.5		October	7.1
	>250 000	15.4		November	7.5
Land use or locality	Rural	5.5		December	6.1
	Business	7.0			
	Industrial	7.9			
	Residential	7.2			
	School	6.6			
	Park	5.3			
	Private property	6.8			

[a] Lap belt with or without shoulder belt.

serious (type A) injuries sustained was only 3.9 percent. The difference between safety-belt use and what would be expected if safety belts did not affect severity was a factor of six for fatal accidents and two for serious injuries.

The percentage of occupants who sustained a given type of injury was also determined as a function of safety-belt use, and these data are also given in Table 2. The data indicate the larger percentage of occupants who were either killed or severely injured while not wearing a safety belt. The most impressive statistic was that, of 653 fatalities, only 8 involved occupants who were wearing safety belts. The obvious conclusion is that the chances of being killed or severely injured in an accident are greatly reduced by wearing a safety belt.

Wearing a safety belt is of significant benefit regardless of where the occupant sits in the vehicle (Table 2). Passengers in the front seat sustained more severe injuries than those in the rear seat, but wearing a safety belt did reduce the severity of their injuries. The largest reduction in injury severity was for rear-seat passengers. Although severe injuries were substantially reduced, "possible" injuries (type C) increased for occupants who wore safety belts. This is attributable to the reduction in the severity of injuries from type A or type B to type C.

If only the total percentage of injuries is cited, there would appear to be no large difference between wearing and not wearing a safety belt. The most important difference, of course, is the severity of the injuries.

The effectiveness of safety belts for different types of accidents was also investigated. Safety belts reduced the severity of injuries in all types of accidents, but the greatest reduction occurred in fixed-object and single-vehicle accidents, as indicated below (drivers wearing a safety belt were wearing a lap belt with or without a shoulder harness):

Type of Accident	Safety-Belt Use by Driver	Percentage of Accidents	
		Fatal Injury	Type A Injury
Angle	Not wearing	0.09	1.5
	Wearing	0	1.1
Head-on	Not wearing	0.48	3.3
	Wearing	0.21	1.8
Rear-end	Not wearing	0.03	0.5
	Wearing	0.01	0.3
Fixed object	Not wearing	0.58	4.0
	Wearing	0	2.3
Single vehicle	Not wearing	0.37	8.1
	Wearing	0	6.6

The reduction in severity is better demonstrated by re-

lating severity to the part of the vehicle damaged (see Table 3). Whereas damage to the top of the vehicle (rollover) resulted in far more fatalities and severe injuries than any other type of accident when the occupants were not wearing safety belts, there were no fatalities in rollover accidents when occupants were wearing safety belts. All fatalities that involved an occupant who was wearing a lap-and-shoulder harness were the result of frontal impacts.

The severity of injuries was also related to safety-belt use according to the type of highway on which the accident occurred (Table 2). When safety belts were used, the largest reduction in injury severity occurred on Interstate routes and parkways, and the least reduction occurred on urban streets. The speeds on these highways and the types of accidents peculiar to them were the primary distinguishing factors. However, injury severity was reduced on all types of highways studied.

It is not surprising that very few drivers in older automobiles used shoulder belts. In new automobiles, however, the lap-and-shoulder harness is a single device; if the driver fastens any of the straps, both the lap belt and the shoulder belt engage. Therefore, the percentages of shoulder-belt use from 1974 to the present time should be much higher. It is obvious that a radical change occurred in 1974, when shoulder-belt use increased from 6 to 28 percent; in 1977, shoulder-belt use was 31 percent.

The types of bodily injuries sustained by drivers who did not wear safety belts and drivers who did wear them were compared (see Table 4). The model year of the vehicle was also considered to illustrate the differences between injuries sustained by drivers while wearing a lap belt and those sustained while wearing a lap-and-shoulder harness. A major difference was the reduction in head and face injuries, particularly when shoulder belts were used. Multiple injuries were also reduced by using safety belts.

The percentages of some types of injuries—neck injuries, for example—were higher for some users of safety belts.

Factors that Affect Safety-Belt Use

Analysis of accidents, field observations, and questionnaire data produced relations between safety-belt use and several variables. These data are summarized in Tables 5-7. Usage rates increased markedly for the following categories: certain types of vehicles, newer automobiles, automobiles on Interstates and parkways and in large cities, out-of-state automobiles, drivers in comparison with passengers, drivers over 25 years of age, drivers with professional occupations, drivers with a college education, and graduates of driving schools.

Mandatory Use of Safety Belts

An item on the questionnaire asked drivers' opinions of a law that would require the use of safety belts. A summary of the response of the general driving population and that of high-risk drivers is given below:

Opinion	General Driving Population (%)	High-Risk Drivers (%)
Strongly in favor	10	8
In favor	22	19
Neutral	35	42
Against	23	24
Strongly against	10	7
Total	100	100

In both groups, approximately the same percentage of drivers were in favor of and against such a law. Among the general driving population, approximately one-third of drivers were in favor, one-third were neutral, and

Table 6. Safety-belt use by drivers in relation to variables that affect usage (based on accident data).

Variable	Category	Percentage of Drivers Using Safety Belts*	Variable	Category	Percentage of Drivers Using Safety Belts*
Sex	Male	9.0	Character of roadway	Straight	9.2
	Female	9.0		Curved	8.1
Age (years)	<25	7.0		Straight and level	9.5
	25-49	10.3		Straight and grade	8.0
	≥50	10.1		Straight and hill crest	7.9
Driver residence	Local	8.8		Curved and level	8.2
	Elsewhere in the state	9.9		Curved and grade	8.2
	Out of state	12.7		Curved and hill crest	7.5
Type of vehicle	Automobile	9.0	Number of vehicles involved	Single vehicle	8.4
	Automobile with trailer	10.5		Multiple vehicle	9.0
	Single-unit truck	6.6			
	Combination truck	12.1	Contributing circumstance	Alcohol	3.9
	Taxi	4.3		Drugs	4.3
	Bus	12.0		Physical disability	9.6
	School bus	15.6		Driver error	8.4
	Emergency	36.3		No driver error listed	9.4
Road surface condition	Dry	8.8	Make of vehicle	Buick	8.7
	Wet	9.6		Cadillac	11.5
	Snow or ice	10.7		Chevrolet	8.0
Weather condition	Clear	8.5		Chrysler	9.9
	Raining	9.8		Datsun	13.0
	Snowing	10.2		Ford	9.3
	Sleet or hail	12.7		Plymouth	9.4
Light condition	Daylight	9.0		Pontiac	9.5
	Dawn or dusk	9.5		Toyota	14.4
	Darkness, lighted	9.0		Triumph	14.7
	Darkness, not lighted	9.2		Volkswagen	8.9
Number of occupants, including driver	1	9.6		Volvo	19.8
	2-3	8.8	Model year	Pre-1966	4.2
	4-6	8.3		1966-1971	6.6
	>6	11.4		1972	10.2
Type of accident	Angle	9.9		1973	12.1
	Head-on	6.2		1974	12.6
	Rear-end	9.9		1975	13.2
	Fixed-object	7.6		1976	13.3
	Single-vehicle	8.4		1977	17.5

*Lap belt with or without shoulder belt.

Table 7. Safety-belt use as determined by questionnaire survey of the general driving population.

Driver Characteristic	Category	Percentage of Drivers Using Safety Belts
Age (years)	<25	23.9
	25-49	23.4
	≥50	29.8
Sex	Male	25.1
	Female	25.9
Occupation	Unskilled	21.2
	Semiskilled	20.6
	Skilled	21.8
	Professional	40.4
	Student	34.4
	Sales	25.0
	Housewife	23.6
	Unemployed	29.2
Education	Did not complete high school	20.0
	Completed high school	21.7
	More than high school	24.4
	Completed college	41.9
Population of city of residence	>60 000	29.1
	15 000-60 000	29.1
	2500-14 999	21.9
	<2500	20.9
Marital status	Married	24.8
	Single	30.9
	Divorced or separated	14.1
	Widowed	35.7
Annual family income ($)	<6500	23.2
	6500-12 000	24.5
	12 000-18 000	24.2
	>18 000	28.8
Number of dependents (other than self)	0	30.4
	1	25.7
	2	26.9
	3	22.3
	4	18.6
	>4	28.8
Driving experience (years)	1	24.4
	2-5	24.4
	6-10	24.5
	11-20	24.4
	>20	26.6
Avg distance driven per year (000 km)	<8	27.0
	8-16	24.2
	17-24	28.9
	25-32	20.1
	33-48	23.3
	>48	23.7
Method of learning to drive	Family and/or friend	23.8
	High school driver training	26.3
	Driving school	41.2
Night driving (%)	0-10	25.9
	11-20	30.0
	21-30	21.9
	31-40	26.5
	41-50	22.2
	>50	35.7
Road type on which most driving is done	Interstate and toll roads	31.1
	Other four-lane roads	27.6
	Two-lane roads	23.4
Trip purpose for which largest amount of driving is done	Work-related	24.8
	Short, non-work-related	25.8
	Long, non-work-related	30.4
Vehicle Model year	Pre-1966	28.0
	1966-1971	23.5
	1972 to present	26.3
Style	Compact	28.0
	Midsized	30.1
	Full-sized	24.1
	Sports	21.2
	Truck	20.9
Engine size (number of cylinders)	4	27.0
	6	23.0
	8	25.4
Points currently on driving record	0	25.8
	3	19.4
	4-6	18.2
Accident in past 2 years	No	25.4
	Yes	21.4
Self-testing attitude	High	20.1
	Intermediate	21.4
	Low	28.3

one-third were against a law that requires the use of safety belts.

An analysis was made to determine whether there were any major differences among drivers who were in favor of or against such a law. Several driver characteristics were compared with the answer given by the drivers, including age, sex, education, residence, marital status, income, driving record, safety-belt use, amount of driving, and method of learning to drive. As expected, the main difference between the two groups of drivers was in their reported use of safety belts: Twice as many drivers who wore safety belts were in favor of such a law as drivers who did not wear them. The other differences noted also related in some way to safety-belt use. For example, among drivers who favored such a law, the percentage who had a college education was greater than the percentage who had less than a high school education, and college graduates were also found to have a higher rate of safety-belt use.

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Automobile Fuel Economy and the Driver

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The results of a study of the effect of driver characteristics and behavior on automobile fuel consumption and methods for improving driver fuel economy are presented. The fuel economy of 74 drivers was recorded for each of 10 trips over a 5.6-km (3.5-mile) urban test route on which there were 14 stops and 21 turns. Deceleration and acceleration rates as well as engine vacuum and tachometer readings were recorded for each trip. Driver fuel economy was related to the age and sex of drivers, maximum deceleration and acceleration rates, minimum engine vacuum, and maximum engine speed during accelerations. It was found that driver fuel economy is not related to the driver's age or sex and is about the same whether or not the driver makes full stops at all intersection stop signs. Correlation between driver fuel economy and minimum engine vacuum and maximum engine speeds during acceleration was fairly good. Correlation was poor between fuel economy and maximum rates of deceleration and acceleration. The study findings include an assessment of the usefulness of the vacuum gauge in assisting drivers to conserve fuel. The data indicate that many drivers would use more fuel with the vacuum gauge than without it.

During the fall of 1975, the fuel-economy and driving habits of 74 drivers were observed as each drove a 1972 Chevrolet sedan 10 times over a 5.6-km (3.5-mile) urban test route on which there were many stops and turns (nonuniform driving). On each trip, total fuel consumption, patterns of acceleration and deceleration rates, engine vacuum readings, and engine speeds during acceleration were recorded. Pertinent remarks on driver behavior were also recorded, including observations on whether full stops were made at stop signs and whether speed was reduced near schools and hospitals. Vehicle, road, traffic, and weather conditions were the same for all trips.

The study was part of a Federal Highway Administration (FHWA) project reported on elsewhere (1). The results reveal how individual drivers affect automobile fuel consumption and how fuel economy can be improved without sacrificing driving convenience or safety.

DETAILS OF THE STUDY

Drivers

The drivers consisted of 44 men and 30 women, distributed by age as indicated below:

	Number of Drivers	
Age (years)	Male	Female
10-20	0	1
20-30	2	4
30-40	8	5
40-50	21	12
50-60	8	8
60-70	4	0
70-80	1	0
Total	44	30

Almost 50 percent of the drivers were in the 40- to 50-year-old group. Eleven were housewives; 29 were professionals; 29 were laborers, clerks, or salespersons; 3 were students; and 2 were retired persons. The drivers were all responsible people who agreed in advance to drive the test runs as they normally drove even if they were accustomed to exceeding the speed limit or tended to go through intersections protected by stop signs without making full stops (unless another vehicle was approaching). Each driver was in good health and accustomed to driving in urban areas.

Test Route

A sketch of the test route is shown in Figure 1. From the beginning point shown in the figure, the route followed a path over to the street that passes in front of the high school. From here the route went twice around the four-block area across from the high school and then retraced the path back to the beginning point. On each trip, the driver encountered 14 intersection stop signs, made 21 turns, and passed twice in front of a large church, a hospital, and a high school. Since traffic volumes were low and there were no traffic signals, the amount of delay at intersection stops was attributable to the habit of the driver rather than to the need to wait either for a gap in cross-street traffic or for a traffic signal to change.

Vehicle

The test automobile weighed 1996 kg (4400 lb) empty and had an eight-cylinder, 6554.8-cm^3 (400-in^3) engine and a three-speed automatic transmission. It was equipped with air conditioning, power steering, and front-wheel power brakes. The engine compression ratio was 8.5:1, the rear-axle ratio 3.08:1, and the frontal cross section 2.84 m^2 (30.5 ft^2). The vehicle had H78-15 bias belted tires that carried inflation pressures of 221 kPa (32 lbf/in^2).

Equipment

A photoelectronic fuel meter, a vacuum gauge, an accelerometer, and an engine tachometer were used in the