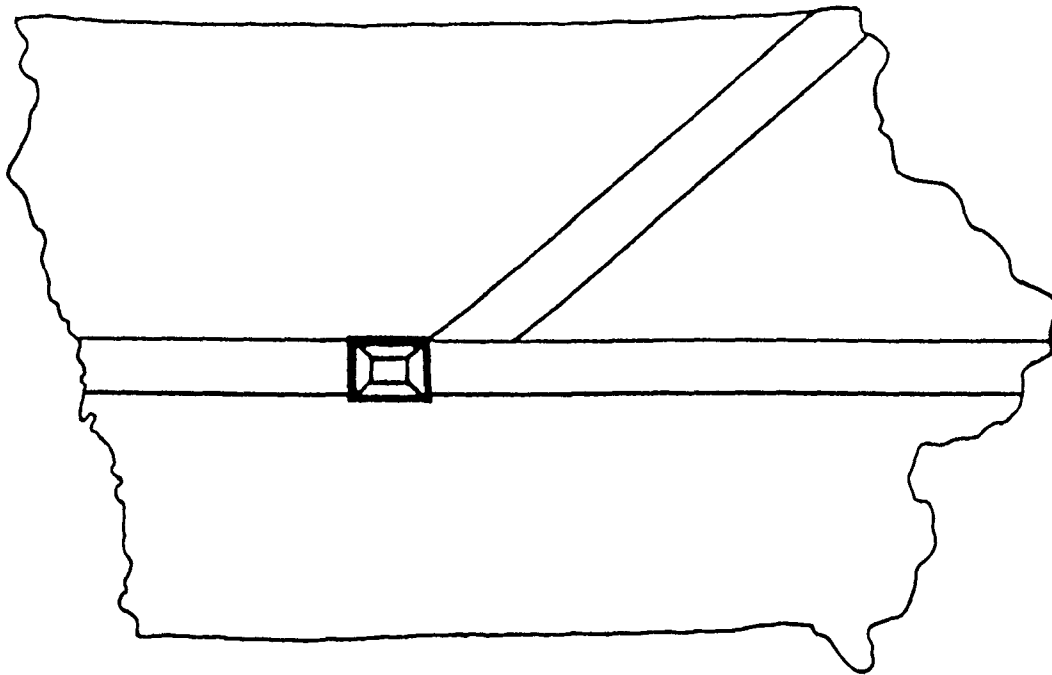# Iowa Safety Restraint Assessment
I.S.R.A.

A study of motor vehicle crash

injuries and hospital charges

in belted and unbelted victims.

November 1987-March 1988

DATE DUE

This report is dedicated to the staff of the participating
hospitals. The role of these nurses, physicians, and
support staff in the care of the injured and their collective
effort in providing the data for this study is truly
significant.

A C K N O W L E D G M E N T S

ACKNOWLEDGMENTS

Iowa Safety Restraint Assessment (ISRA)
Hospital Sites
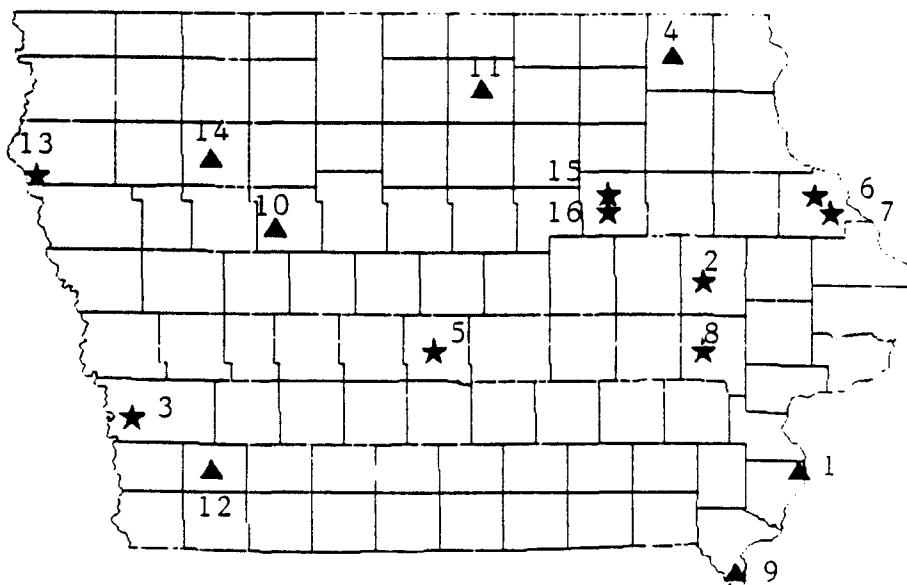
ISRA Sites
(14 cities/towns, 16 hospitals)
★ = Urban, population >50,000
▲ = Rural, population <50,000

T A B L E   O F   C O N T E N T S

E X E C U T I V E   S U M M A R Y

In Iowa during 1987 there were 491 persons killed and over
25,000 injured in motor vehicle crashes. Traffic accidents
are the leading cause of death in the age group 5 to 34. The
average person has a 1 in 3 chance of suffering a disabling
injury as a result of a motor vehicle crash during their
lifetime. Traffic accidents cost Iowans over $ 300 million
annually in related costs including emergency, health,
welfare and legal services; administrative costs; lost
productivity; survivor benefits; and other direct and
indirect costs.

The Iowa Safety Restraint Assessment (ISRA) was developed to
study injuries and medical costs in the belted and unbelted
crash victims who survived and presented for hospital care.
In the 1,454 ISRA crash victims studied, 48% were belted and
52% unbelted. Comparison of the belted and unbelted show the
following to occur more often when not using the safety
restraint:

        HEAD INJURY............ 8.5 times more frequent if unbelted
        FRACTURE............... 2.7 x   "   "
        LACERATION............. 2.8 x   "   "
        INJURY SEVERITY SCORE. 2.2 times higher if unbelted
        HOSPITAL BILLS........ 3.3 x   "   "
        HOSPITALIZATION....... 3.0 times more frequent if unbelted
        AVERAGE LENGTH OF STAY 2.4 times longer if unbelted
        PERMANENT DISABILITY.. 7.4 times more frequent if unbelted
        DEATH................. 14.8 x   "   "

Based on a chi-square test, the difference in the number of
head injuries, fractures, lacerations, cumulative injury
severity scores, actual hospital dollar charges,
hospitalization frequency, average length of hospital stay in
days, and occurrence of permanent disability and death are
all statistically significant at the .05, .025, .01, and .005
levels. Victims using the safety restraint had a 54.4%
reduction in their severity of injury, a 66.3% reduction in
the need for hospital admission, and a 69.5% decrease in
hospital charges.

The public has been exposed to conflicting ideas about the
safety restraint. This study clearly shows buckling up to
reduce injuries and medical costs when involved in a motor
vehicle crash. It is important for people to understand the
benefits of the safety restraint so they will be more likely
to comply with its correct and consistent use.

1

P R O B L E M   S T A T E M E N T

Accidental injury and its sequela ranks as one of the nation's most serious health problems. In 1985 the Committee on Trauma Research, Commission on Life Sciences, National Research Council, and the Institute of Medicine described the injury epidemic and proposed methods to address this problem in the book INJURY IN AMERICA (1):

"Injuries kill more Americans aged 1 - 34 than all diseases combined for that age group and are the leading cause of death up to the age 44.

The injured occupy one of eight hospital beds. The cost of their medical care is enormous. In 1982 this was over 19 billion dollars for the cost of treatment and 41 billion dollars in lost earnings.

Injuries are one of the most expensive health problems, costing over $ 75 - 100 billion a year in direct and indirect costs.

Motor vehicle crashes are the most common cause of injury and death from injury. A large number of fatalities have been studied by the National Highway Traffic Safety Administration through the Fatal Accident Reporting System (FARS). At this time routinely collected data on nonfatal injuries are seriously limited."

Presently the nation's efforts have been devoted to provide treatment for injury. Little attention has been given to evaluate its epidemiology and prevention. Research is needed to determine profiles of risk behavior and what health safety practices work when exposed to trauma.

Prevention of injury when involved in a motor vehicle crash involves the vehicle crash-worthiness and use of safety protective devices. Motor vehicles are now equipped with safety restraints but the majority of the occupants have failed to use them.

This study is designed to evaluate the injuries received in the belted and unbelted victims of motor vehicle crashes. The following questions were of special interest:

1) What are the patterns of injury seen in the belted and unbelted, and do they differ in severity?

2) What are the associated hospital bills for treatment of injuries in the belted and unbelted, and do they differ?

3) Does safety restraint use significantly reduce injuries and/or their associated medical bills for treatment?

2

S T U D Y   D E S I G N   &   M E T H O D

The Iowa Safety Restraint Assessment (ISRA) was modeled after
the crash injury and hospital bill pilot study conducted by
the Department of Emergency Medicine at Keokuk Area Hospital
in Keokuk, Iowa during 1986. The Keokuk study is perhaps the
first of its kind to appear in the medical literature and is
reported by Peterson as "Trauma Prevention from the Use of
Seat Belts" in the May 1987 issue of IOWA MEDICINE. (2)

The ISRA was designed with insite derived from the pilot
study. This approach with the same study director allowed
for an experienced perspective toward inservicing and
gathering of similar data from hospital sites.

The statewide study (ISRA) was designed as follows:

Victims of motor vehicle crashes presenting for emergency
care at 16 Iowa hospitals representing all levels of trauma
care were included in the study. A mix of 7 rural and 9
urban hospitals in geographic areas representing all
quadrants of the state of Iowa were included (map page ii).

Criteria for inclusion and exclusion of crash victims were:

Inclusion: All occupant victims of motor vehicle crashes who
             presented to the emergency department for
             evaluation and / or treatment at the selected
             hospital sites were to be included if use or
             non-use of the safety restraint was known. This
             was determined by asking the patient. If the
             patient was unable to answer or didn't remember,
             the prehospital emergency medical service or law
             enforcement providers who were present at the
             scene of the accident were asked if they knew.

Exclusion: Pedestrians struck by a vehicle; persons riding
             motorcycles, bicycles, mopeds, and all-terrain
             vehicles, persons in school buses, and those
             persons whose belt status was uncertain by
             history were not included in the study.

The sample period was from November 1987 through March 1988.
Approximately 20% of all motor vehicle crash victims
presenting to hospitals for emergency care in the state of
Iowa during this time were included in the study.

Pertinent hospital staff and site supervisors were inserviced on completing the data collection form (appendix B). Identifying data, accident data, safety restraint use data, injuries diagnosed (per physician) and their location, and disposition were completed by the emergency department nurses. Another source of information was from the prehospital emergency medical service and law enforcement personnel who were present at the crash scene. Total patient hospital charges (excluding physician, ambulance, and rehabilitation bills; see appendix A) were recorded by the hospital billing department.

Each site had one or two coordinators identified to direct the data collection process and review the data form for completeness. These coordinators also included final data on admitted patients prior to submitting the forms for the study. The hospital sites were requested to list and refer to the victims by chart number only. At no time were patient names to be released for the purpose of this study.

Iowa Methodist Medical Center, Central Iowa's designated trauma center, served as the data evaluation site. The study coordinator at this site attended the American Association of Automotive Medicine's course on injury severity score coding. For the sake of consistency this person calculated the Injury Severity Score (ISS) for each victim and assigned the Abbreviated Injury Score (AIS) coded for the injuries reported. (3) Data was entered into a computer to allow for analysis and reporting.

ISRA
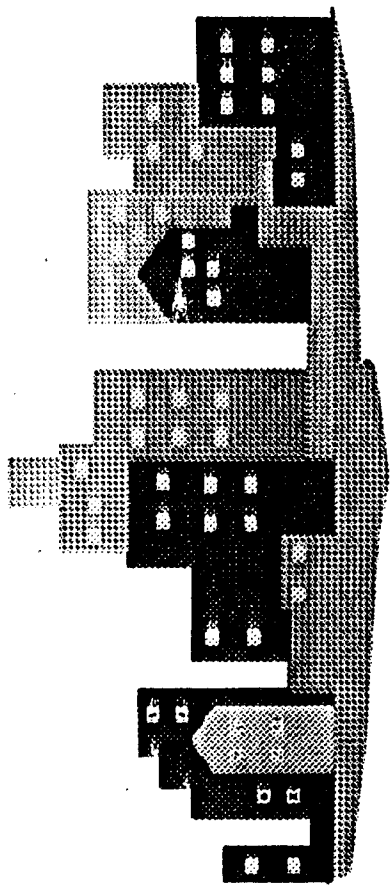
REPORTS
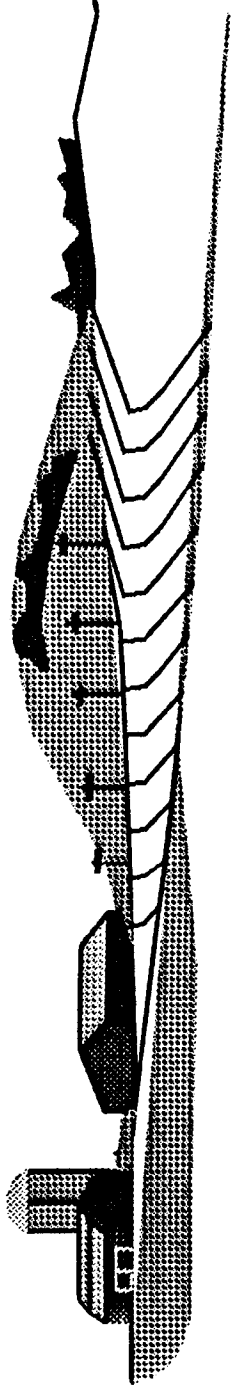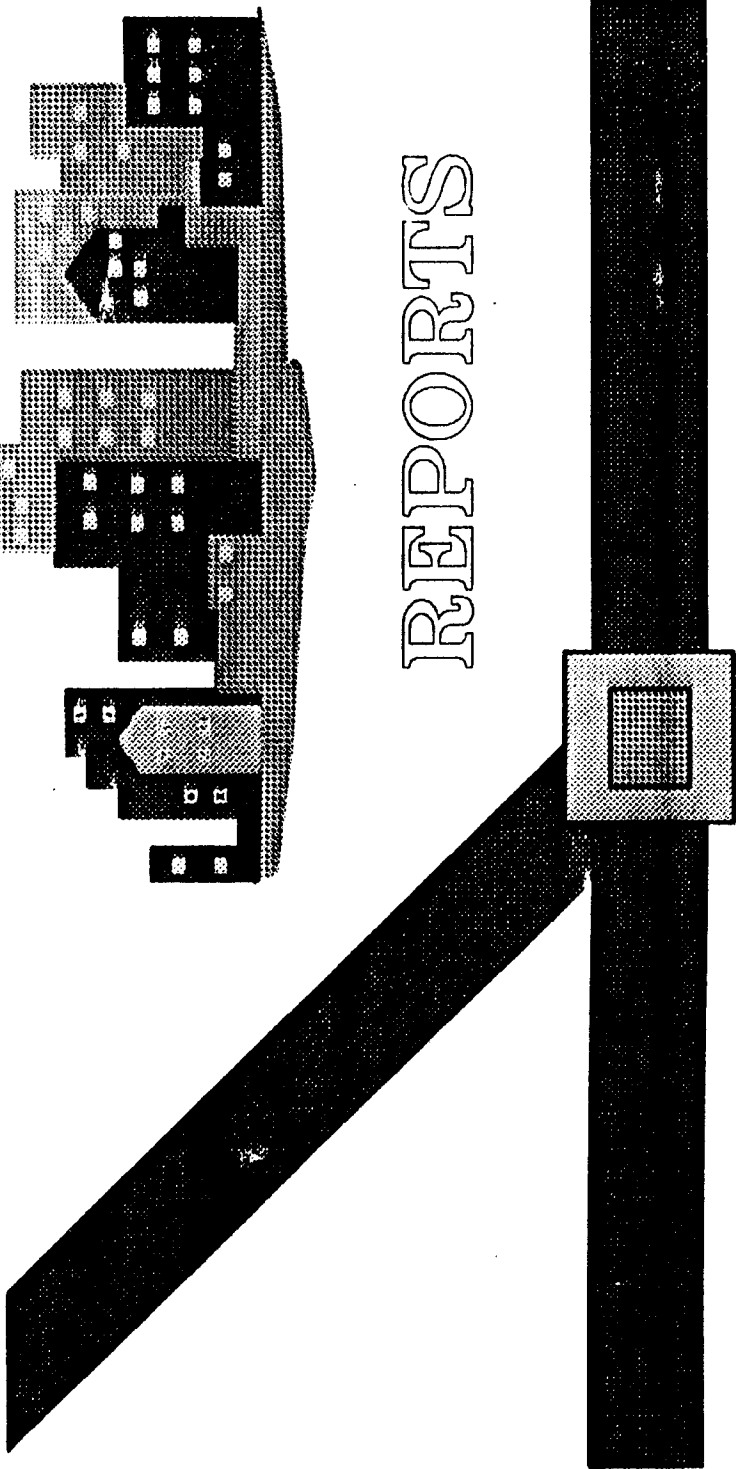
ISRA

AGE OF CRASH VICTIMS

Number of Persons

600

500

400

300

200

100

0

109

6   17   24

0-6 mo.   7mo.-2 yr.   3-5   6-15

Age in Years

N = 1447

UNKNOWN AGE = 7

5

ISRA

AGE OF CRASH VICTIMS

Number of Persons

A bar chart titled "AGE OF CRASH VICTIMS" with y-axis "Number of Persons" (0 to 600) and x-axis "Age in Years". Bars: 16-24 = 551, 25-34 = 295, 35-59 = 297, 60-69 = 83, >70 = 65.
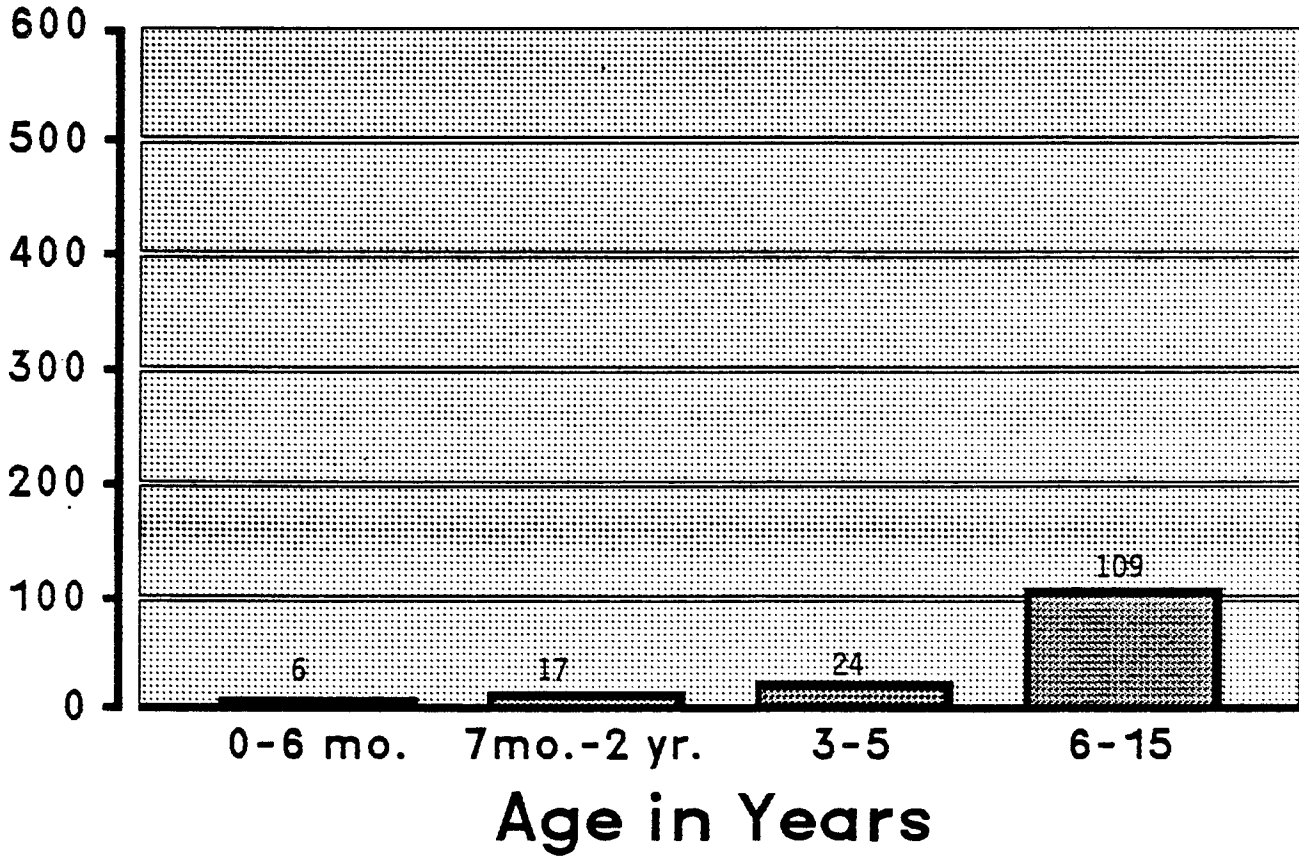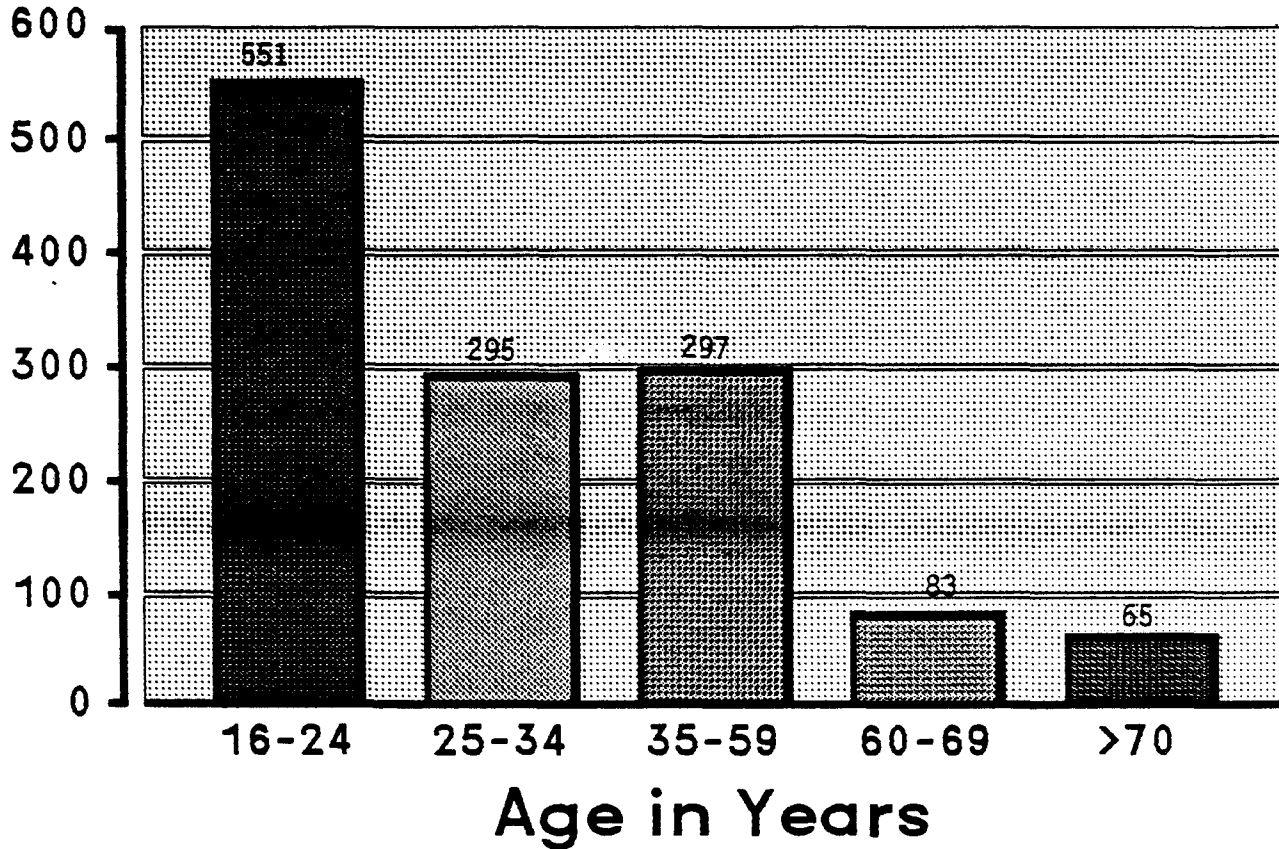
AGE GROUP	% of SAMPLE
Unknown	0.5
0 - 6 Mo.	0.5
7 Mo. - 2 Yr.	1
3 - 5	2
6 - 15	8
16 - 24	38
25 - 34	20
35 - 59	21
60 - 69	6
70+	4
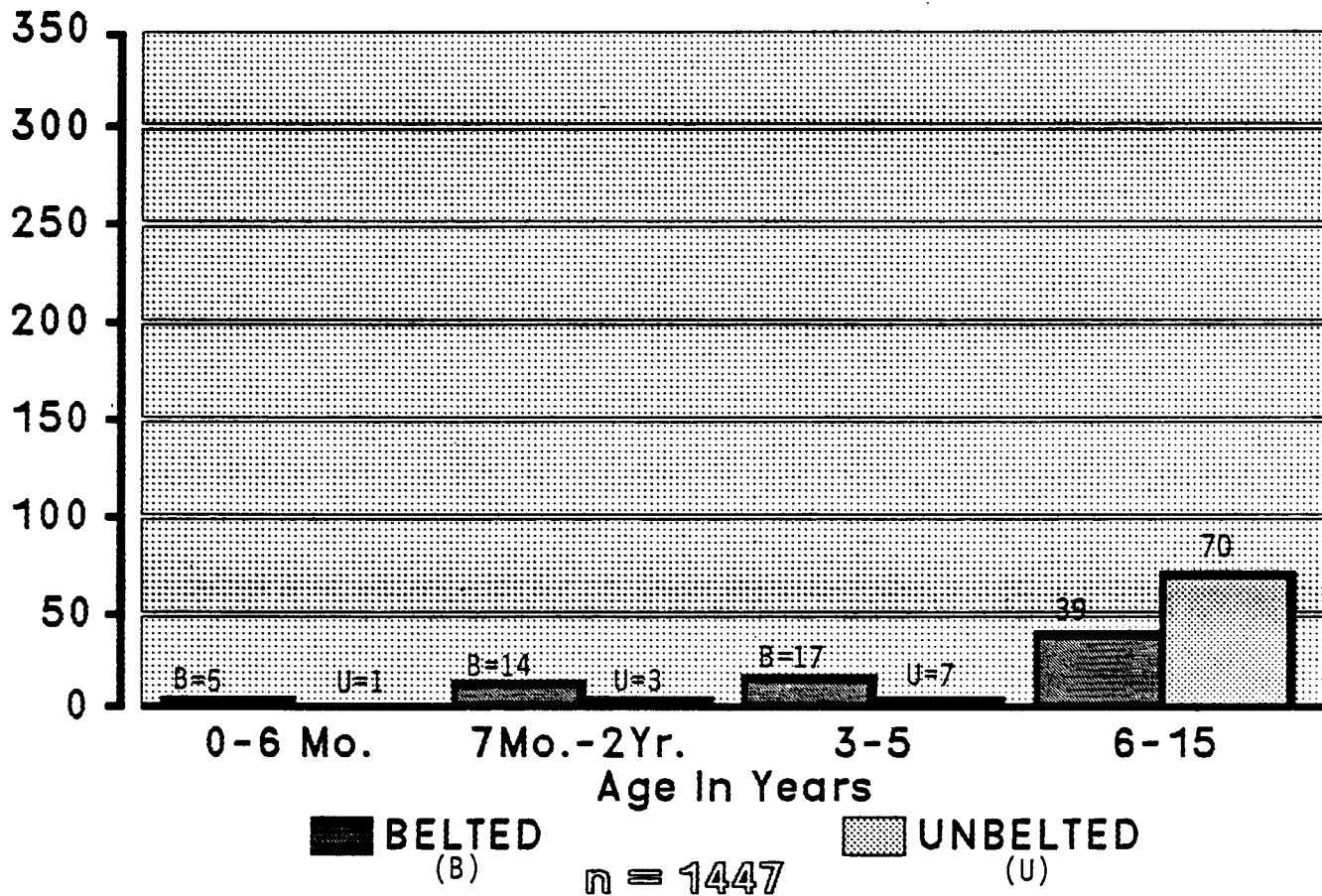
6

ISRA

AGE OF BELTED AND UNBELTED

Number of Persons

BELTED (B)   n = 1447   UNBELTED (U)

Age In Years

ISRA

AGE OF BELTED AND UNBELTED

Number of Persons

Age In Years

■ BELTED   ▨ UNBELTED

8

BELT USE

Belted
41%   MALE   Belted
Unbelted 54%
59%

Male   693 Total
        286 Belted
        407 Unbelted

Unbelted
FEMALE   46%

Female   741 Total
         398 Belted
         343 Unbelted

#20 Gender Unknown

9
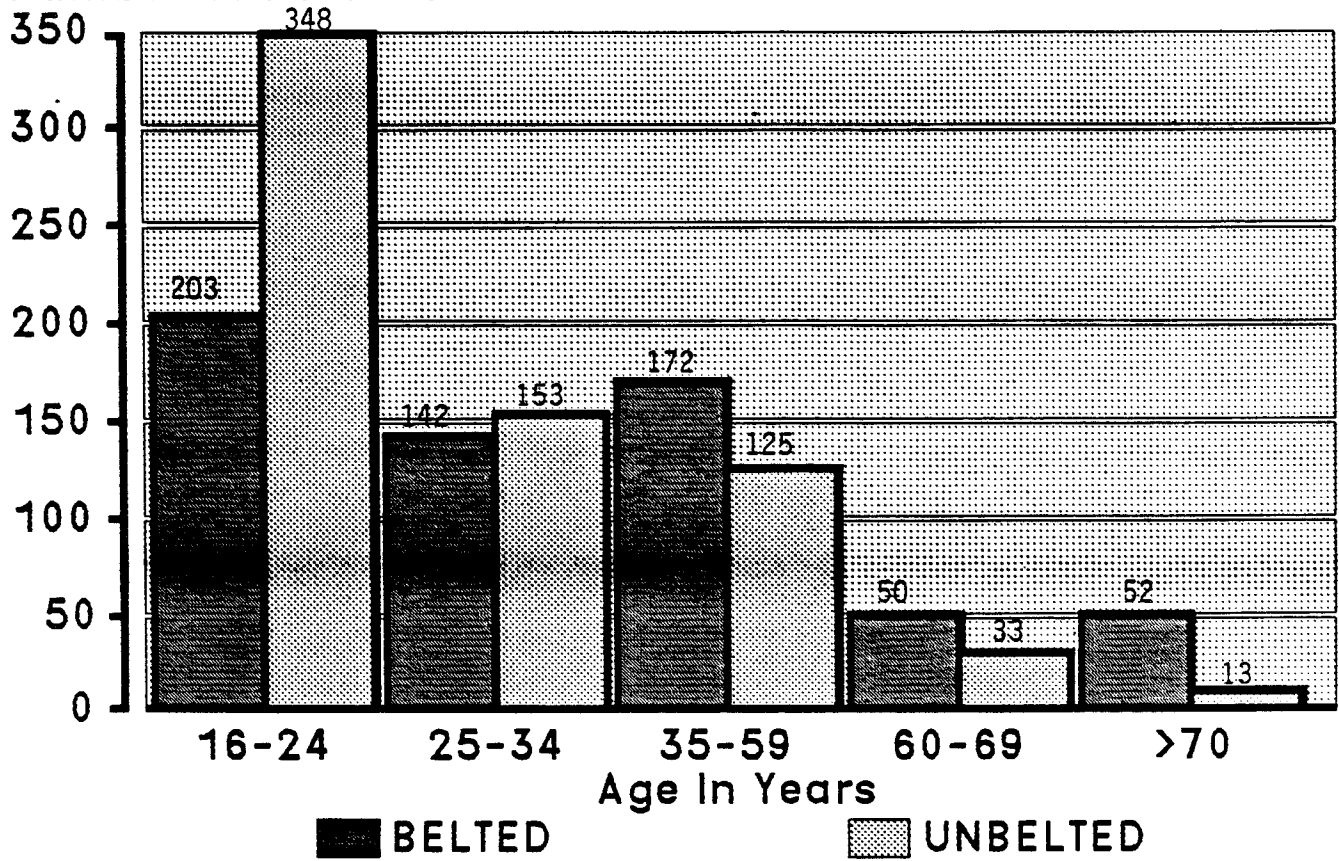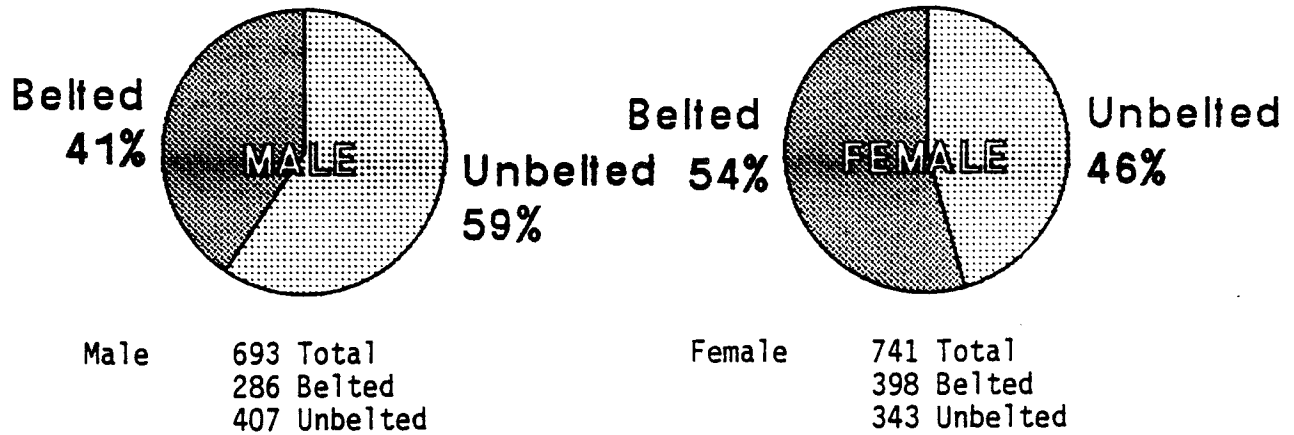
BELT USE
PERCENT OF TOTAL AGE GROUP

Percent
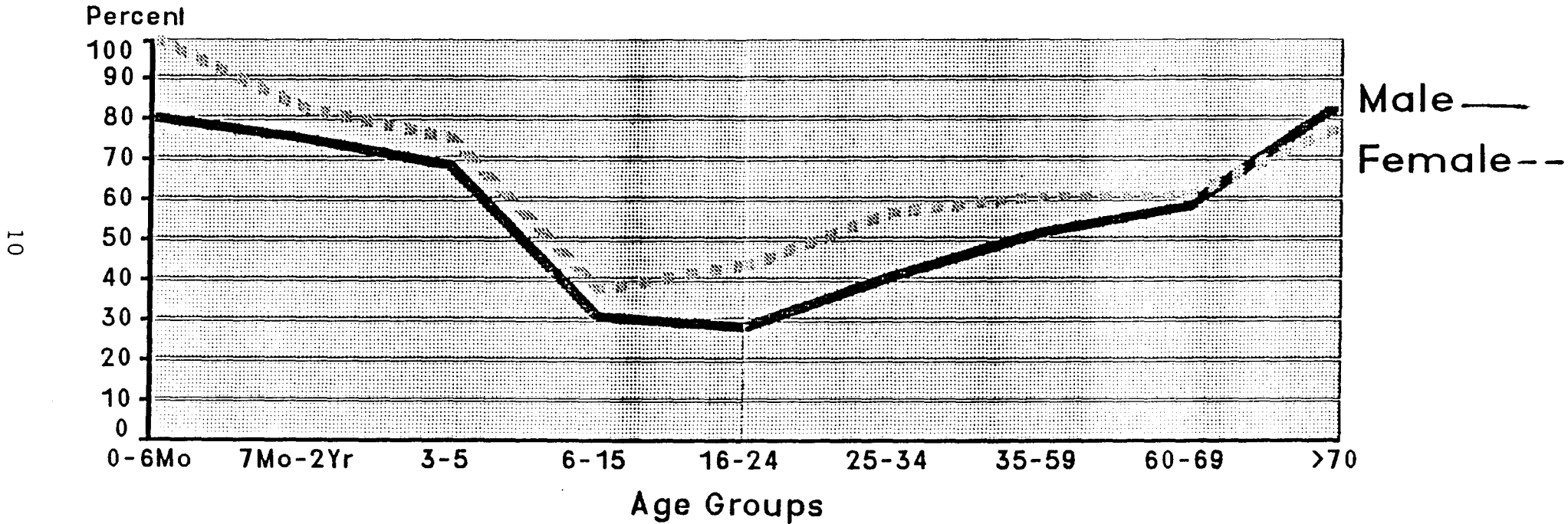
The age groups 6-15 and 16-24 are the least likely to use the safety belt.

Males are consistently less likely to use the belt until age 60 and over.

IMPACT SPEED REPORTED

Number of Persons

Bar chart showing Number of Persons versus Speed (mph):
- 0-9: 102
- 10-19: 140
- 20-29: 302
- 30-39: 374
- 40-49: 242
- 50-59: 209
- >60: 77

Speed (mph)
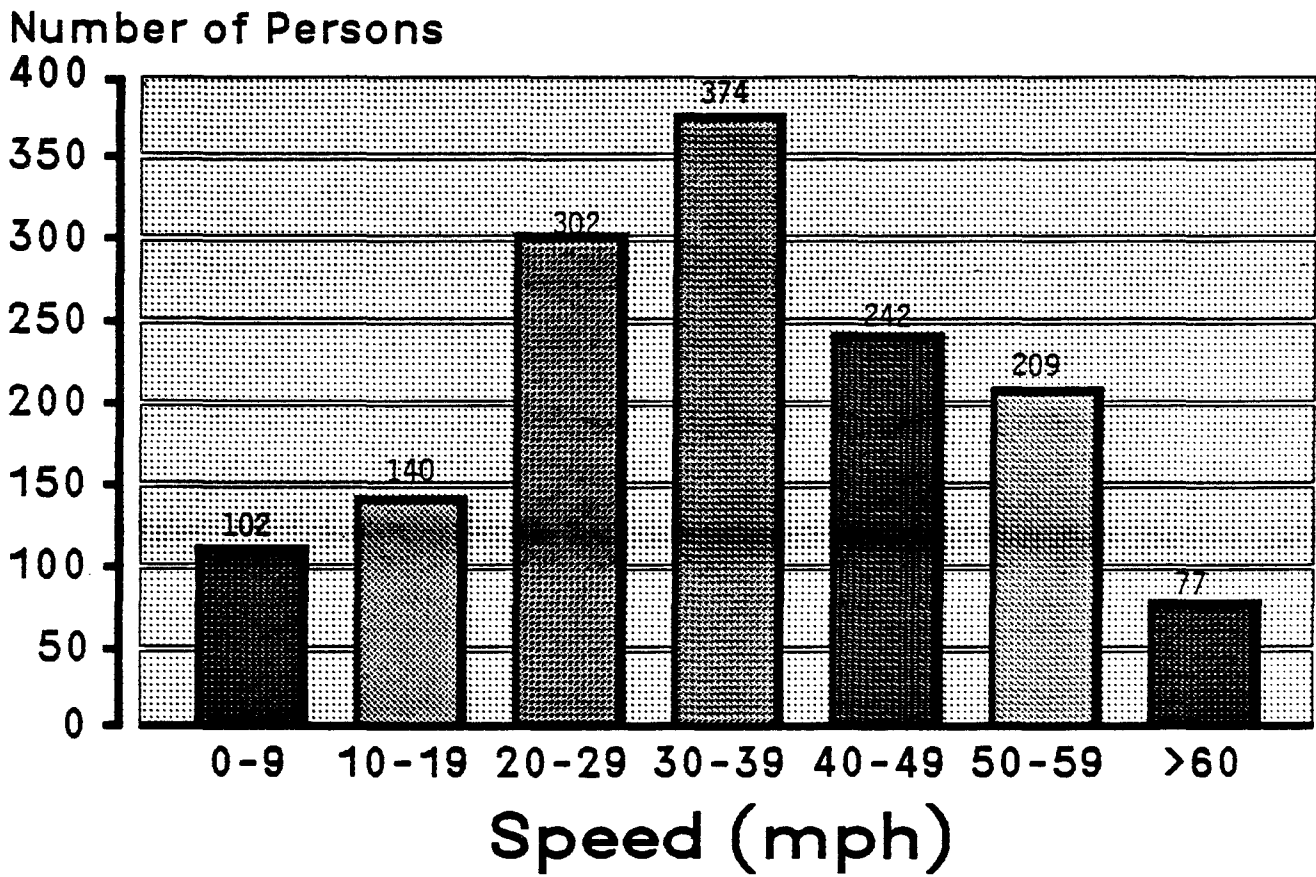
```
Speed Known =  1446
    Unknown =     8

Average Speed Belted   = 32
             Unbelted  = 34
```

11

AVERAGE INJURY SEVERITY SCORE (ISS)
AT IMPACT SPEEDS
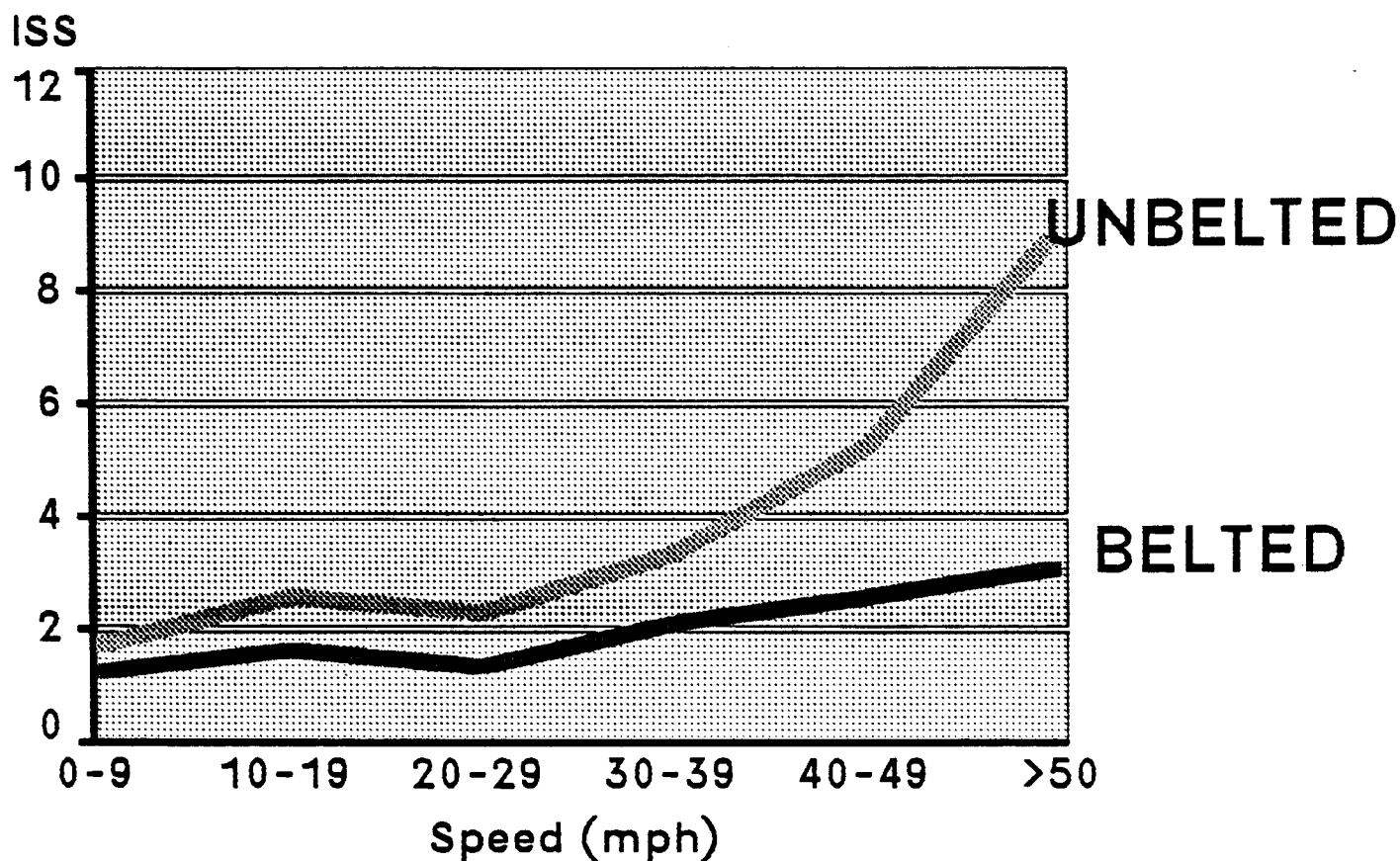
Belts are effective in reducing injury at all speeds

AVERAGE INJURY SEVERITY SCORE (ISS)
UNBELTED : BELTED

ISS Ratio
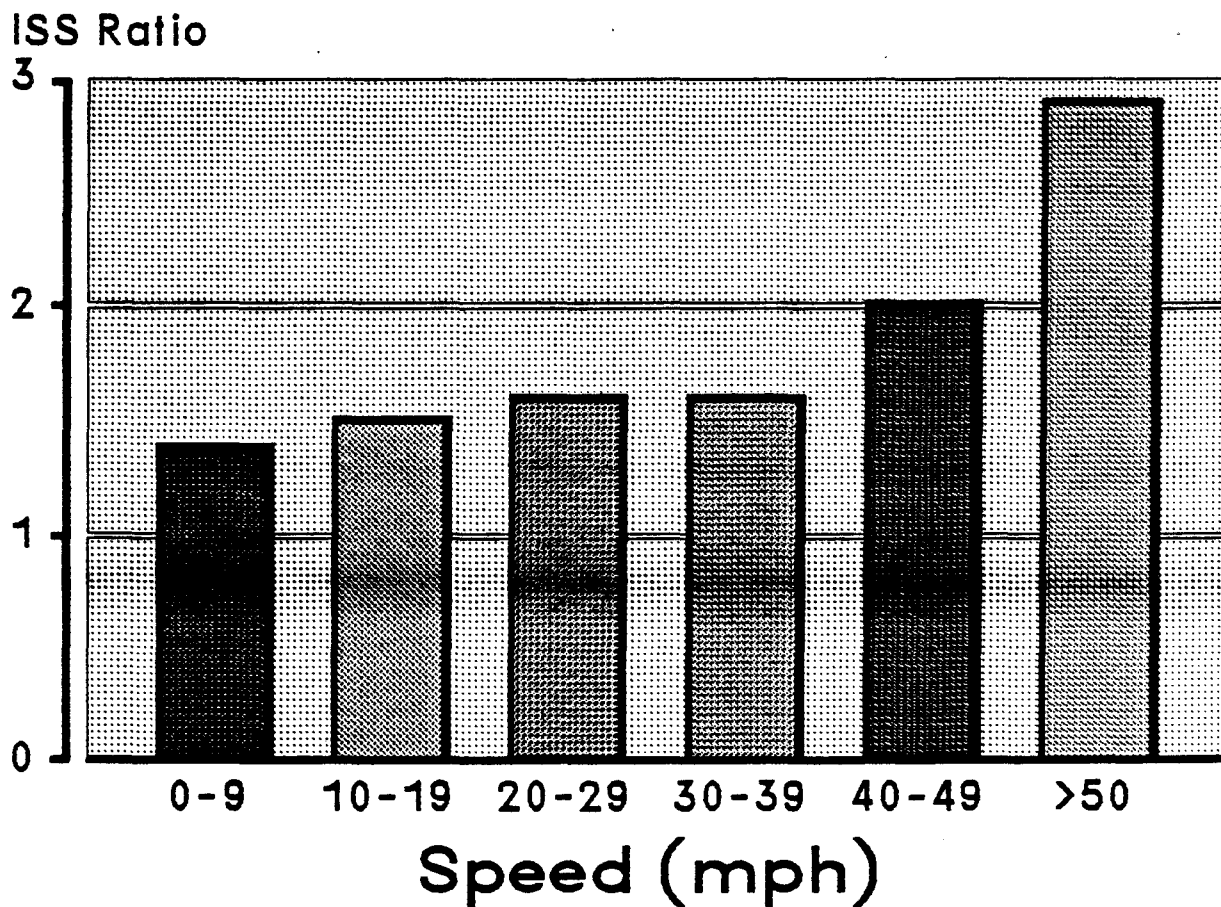
The safety belt has a continuous protective effect which is
constant across low and medium speeds and increases at higher
speeds. At speeds less than 40 the ISS for the unbelted is
1.64 times greater and at speeds 40 and above is 2.48 times
greater than for the belted.

A B B R E V I A T E D   I N J U R Y   S C O R E

The next four pages outline injuries by body region and
severity. The Abbreviated Injury Scale (AIS) system was
used to assign injury severity levels to injuries documented
in the Iowa Safety Restraint Assessment. The injury data
distributions are then compared in the unbelted and belted.

Using the AIS system the body is divided into areas
representing region of injury. Each region has injury
descriptors grouped as follows:

> Whole Area
> Nerves
> Vessels
> Internal Organs
> Skeletal

Body regions and some of the associated injuries are
as follows:

1) EXTERNAL = abrasions, contusion, laceration, avulsion,
              penetrating, degloving and burns

2) HEAD = injuries to skull, brain tissue and scalp

3) FACE = injuries to face, eyes and ears

4) NECK = injuries to spinal cord and nerve roots, vessels,
          upper esophagus, larynx, pharynx, retropharynx,
          thyroid, upper trachea, vocal cords and vertebra.
          (sprains and strains of muscle and soft tissue are
          not included here, they are listed under SPINE)

5) THORAX = penetrating, crush, inhalation, vessels, lower
            trachea, bronchus, lung, lower esophagus,
            diaphragm, heart, ribs, pleura and sternum

6) ABDOMEN & PELVIS = abdominal wall, peritoneum,
          retroperitoneal, vessels, gastrointestinal tract,
          kidney, liver, spleen, pancreas, urogenital and
          reproductive system

7) SPINE = strains and sprains ofmuscle and soft tissue,
          cord contusion and laceration, disc herniation,
          fracture of cervical through lumber levels

8) EXTREMITY = amputation, crush, penetrating, vessels,
          nerves, muscles, tendons, ligaments, bone
          fracture and joint dislocation.

ABBREVIATED INJURY SCALE (AIS) DISTRIBUTION

OF MOST SEVERE INJURY RECORDED PER PATIENT

Unbelted / Belted

(raw data)

AIS SCORE

BODY REGION	1	2	3	4	5	6	totals
1 EXTER-NAL	361 / 292	30 / 4	0 / 0	0 / 0	0 / 0	0 / 0	391/296
2 HEAD	39 / 31	23 / 8	6 / 0	14 / 0	16 / 2	0 / 0	98/41
3 FACE	16 / 6	6 / 1	1 / 0	0 / 0	0 / 0	0 / 0	23/7
4 NECK	0 / 0	1 / 0	0 / 0	0 / 0	0 / 0	0 / 0	1/0
5 THORAX	25 / 23	9 / 9	12 / 9	7 / 2	3 / 1	1 / 0	57/44
6 ABDOMEN & PELVIS	3 / 1	7 / 1	3 / 1	0 / 0	1 / 0	0 / 0	14/3
7 SPINE	160 / 276	20 / 6	5 / 0	0 / 1	5 / 0	0 / 0	190/283
8 UPPER EXTREM	44 / 63	17 / 6	10 / 2	0 / 0	0 / 0	0 / 0	71/71
9 LOWER EXTREM	35 / 28	31 / 23	30 / 10	0 / 0	0 / 0	0 / 0	96/61
totals:	683 / 720	144 / 58	67 / 22	21 / 3	25 / 3	1 / 0	941/806

Some patients are represented more than once given two or more
of their injuries have the same maximum (most severe) score.

ABBREVIATED INJURY SCALE (AIS) DISTRIBUTION

OF ALL INJURIES RECORDED PER PATIENT

Unbelted / Belted
(raw data)

BODY REGION	AIS SCORE 1	2	3	4	5	6	totals
1 EXTER-NAL	762 / 473	59 / 8	0 / 0	0 / 0	0 / 0	0 / 0	821/481
2 HEAD	45 / 38	49 / 15	20 / 1	31 / 3	19 / 2	0 / 0	164/59
3 FACE	27 / 7	15 / 1	3 / 0	0 / 0	0 / 0	0 / 0	45/8
4 NECK	0 / 0	1 / 0	0 / 0	0 / 0	0 / 0	0 / 0	1/0
5 THORAX	48 / 33	18 / 12	28 / 12	21 / 2	3 / 1	1 / 0	119/60
6 ABDOMEN & PELVIS	7 / 4	17 / 2	5 / 1	0 / 0	2 / 0	0 / 0	31/7
7 SPINE	202 / 332	26 / 6	5 / 0	0 / 1	6 / 0	0 / 0	239/339
8 UPPER EXTREM	74 / 81	47 / 11	17 / 2	0 / 0	0 / 0	0 / 0	138/94
9 LOWER EXTREM	55 / 36	50 / 31	51 / 14	0 / 0	0 / 0	0 / 0	156/81
totals:	1220/1004	282 / 86	129 / 30	52 / 6	30 / 3	1/0	1714/1129

All injuries recorded in the belted and unbelted are listed
in the above table according to the assigned AIS score.

The total number of all injuries observed in the belted (1129,
or 1.62 per person) were less than the total number seen in
the unbelted (1714, or 2.26 per person).

AIS SCORE LEVEL COMPARISON

IN UNBELTED AND BELTED (U & B)

AIS SCORE	MOST SEVERE INJURY			ALL INJURIES		
	# U	# B	CHI-SQ TEST	# U	# B	CHI-SQ TEST
1	683	720	not significant	1220	1004	significant to .005
2	144	58	significant to .005	282	86	" "
3	67	22	" "	129	30	" "
4	21	3	" "	52	6	" "
5	25	3	" "	30	3	" "
6	1	0	no comparison	1	0	no comparison

The above table was derived from the preceding two pages
of raw data on AIS scores.

From the above table it is shown that the number of injuries
in AIS levels 1 through 5 were significantly less (.005 level)
in the belted with the exception in the "most severe injury" AIS
level "1" where there was no significant difference determined
by chi-square testing.

In the injury severity level 6 there were no belted victims so
no comparison can be made to the one unbelted victim.

PROPORTION OF INJURIES TO VARIOUS BODY REGIONS

IN UNBELTED AND BELTED (U & B)

BODY REGION	MOST SEVERE INJURY		ALL INJURIES	
	U %	B %	U %	B %
1 EXTERNAL	41.6	36.7	47.9	42.6
2 HEAD	10.4	5.1	9.6	5.2
3 FACE	2.4	0.9	2.6	0.7
4 NECK	0.1	0.0	0.1	0.0
5 THORAX	6.1	5.5	6.9	5.3
6 ABD/PELVIS	1.5	0.4	1.8	0.6
7 SPINE	20.2	35.1	13.9	30.0
8 UPPER EXT	7.5	8.8	8.1	8.3
9 LOWER EXT	10.2	7.5	9.1	7.2
total:	100.0 %	100.0 %	100.0 %	99.9 %

The above table was derived from the first two pages of raw
data on AIS Scores.

Patterns of injury as listed by body region according to AIS
definition showed a reduction of injuries for external, head,
face, neck, thorax, abdomen/pelvis, and lower extremity.
The number of upper extremity injuries were about
the same for "all injuries" but was slightly higher for
"most severe injury".

The resultant redistribution of injury becomes apparent in the
spine region. Injuries here were usually sprains and strains.
The average AIS score in the spine category is less in the
belted (1.05) compared to the unbelted (1.28) reflecting the
fact that when injuries to the spine area occur they are less
severe in the belted. Also the average AIS seen in the spine
region is less than what is observed in the overall study average.

FRACTURE

Percent

```
20 ┐
15 ┤
10 ┤
 5 ┤
 0 ┴
   BELTED        UNBELTED
```
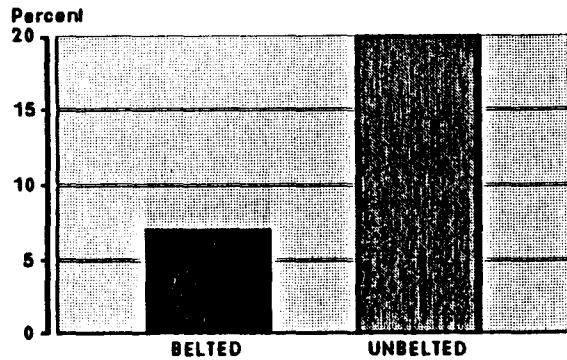
U:B = 2.7

52 belted, or 7.5%
#153 unbelted, or 20.2%

LACERATION

Percent

```
40 ┐
30 ┤
20 ┤
10 ┤
 0 ┴
   BELTED        UNBELTED
```
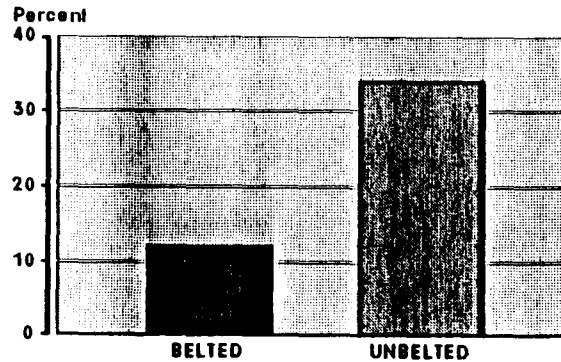
U:B = 2.9

85 belted, or 12.2%

#260 unbelted, or 34.3%

HEAD INJURY

Percent

```
20 ┐
15 ┤
10 ┤
 5 ┤
 0 ┴
   BELTED        UNBELTED
```
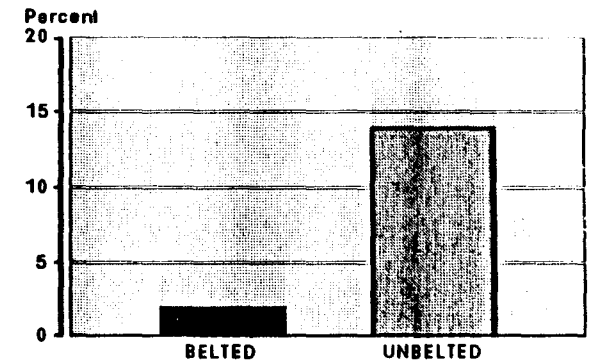
U:B = 8.5

12 belted, or 1.7%

#109 unbelted, or 14.4%

ALCOHOL RELATED CRASH VICTIMS

Number of Persons

N = 257

Age in Years
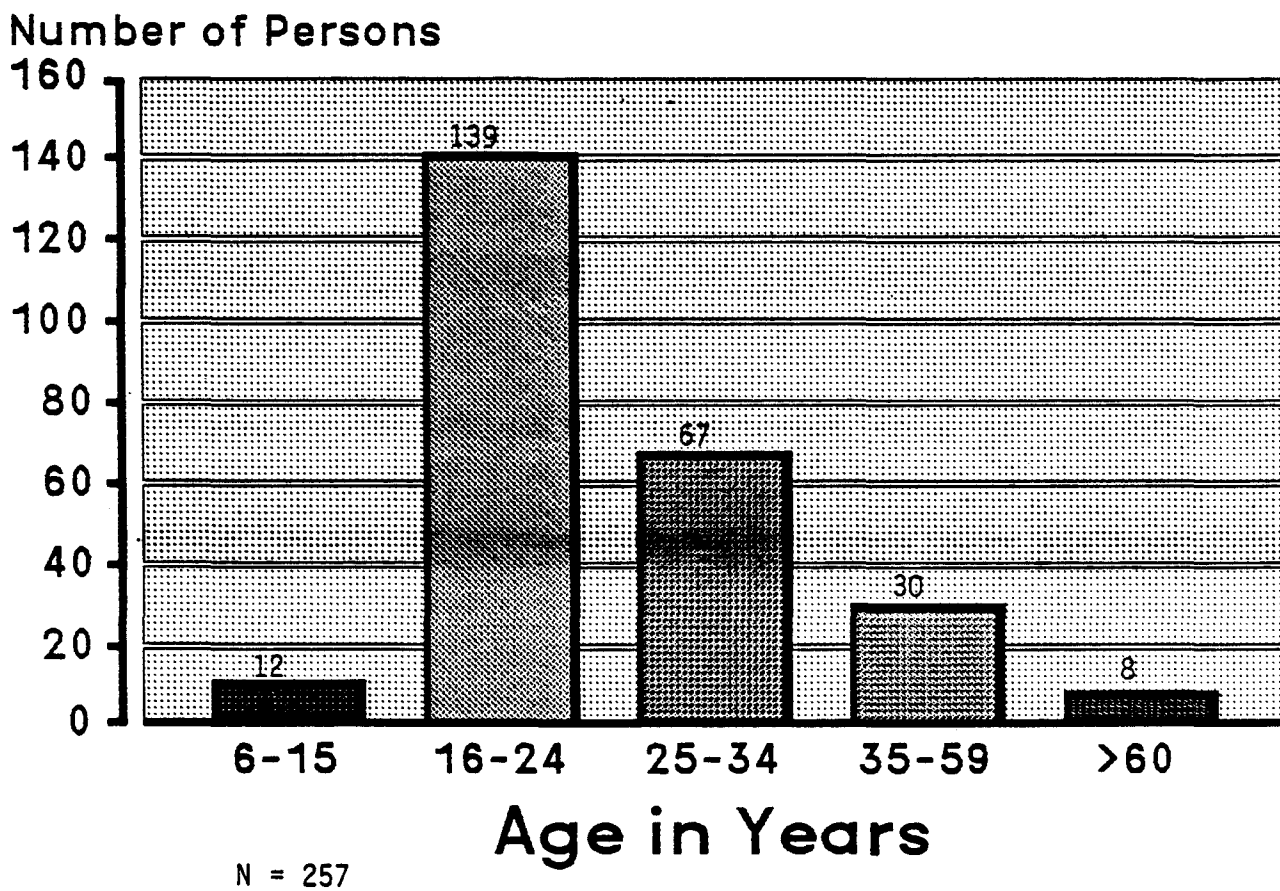
ALCOHOL RELATED
Male and Female Victims
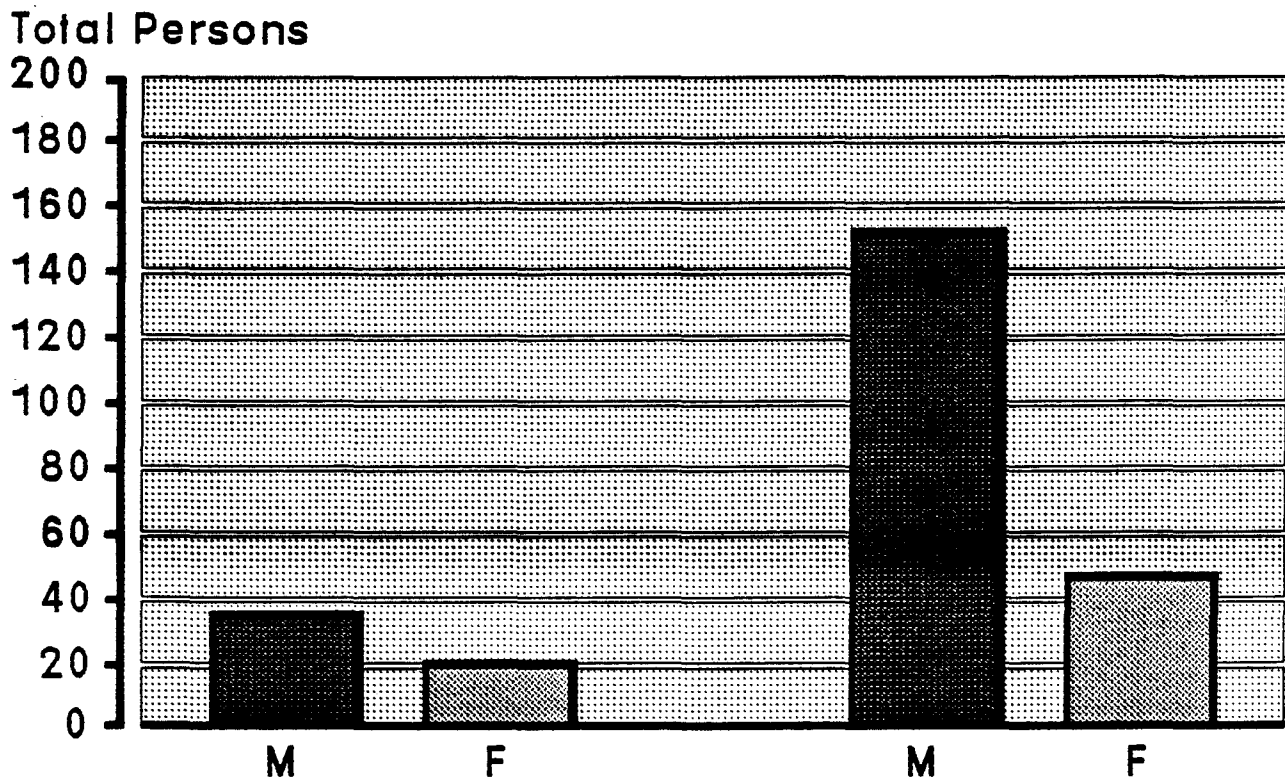
Total Persons

	Belted			Unbelted	
Male	=	36	Male	=	153
Female	=	20	Female	=	47
Unknown	=	1	Unknown	=	0
		57			200

ALCOHOL RELATED CRASH VICTIMS

Number of Persons

A bar chart showing the number of alcohol related crash victims by age group and gender.

Age In Years	MALE	FEMALE
6-15	9	3
16-24	101	38
25-34	54	13
35-59	21	9
>60	4	4

Legend: ■ MALE ▦ FEMALE
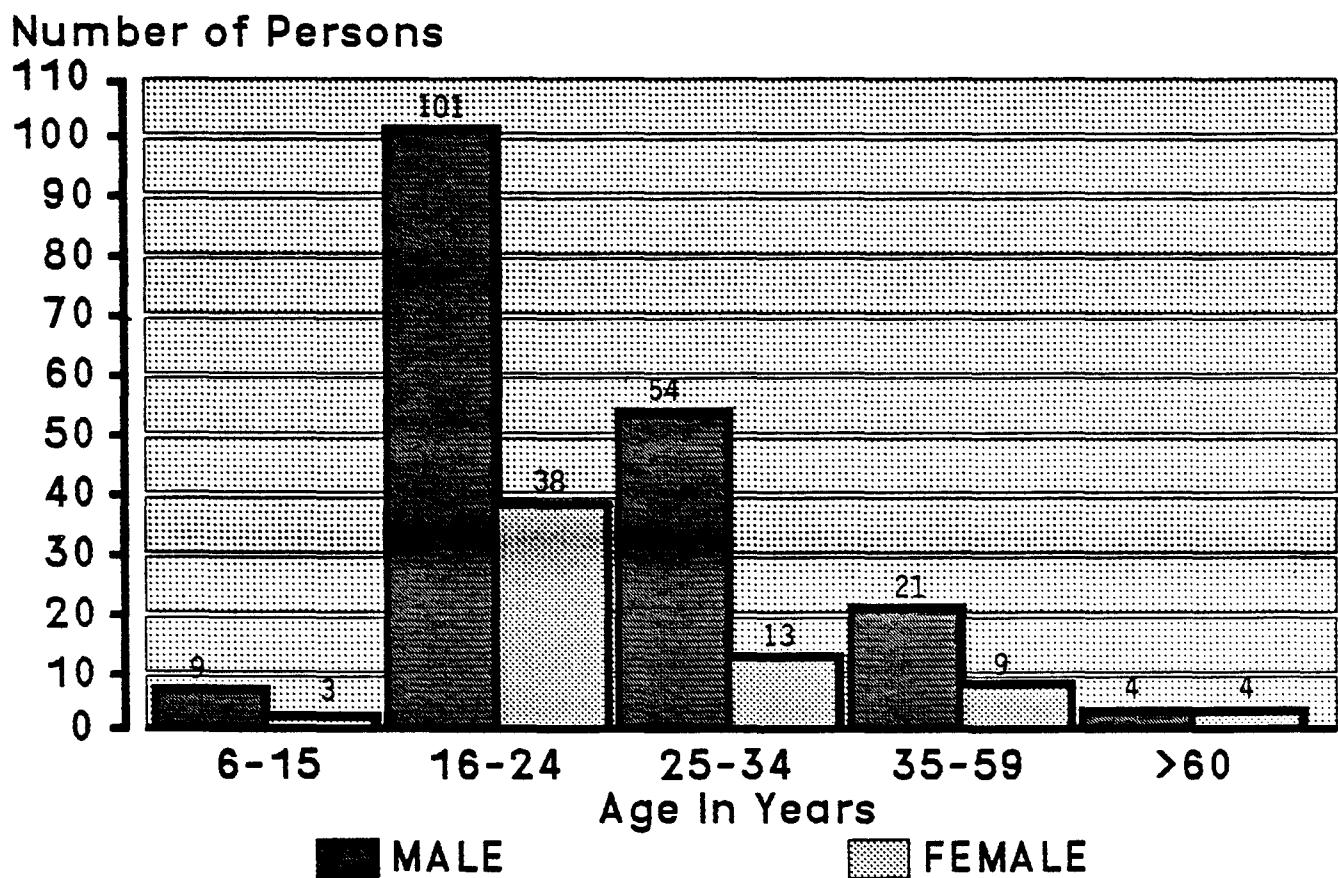
```
Total   = 256
Unknown =   1
```

22

ALCOHOL VICTIMS
PERCENT OF TOTAL AGE GROUP

Percent of Total
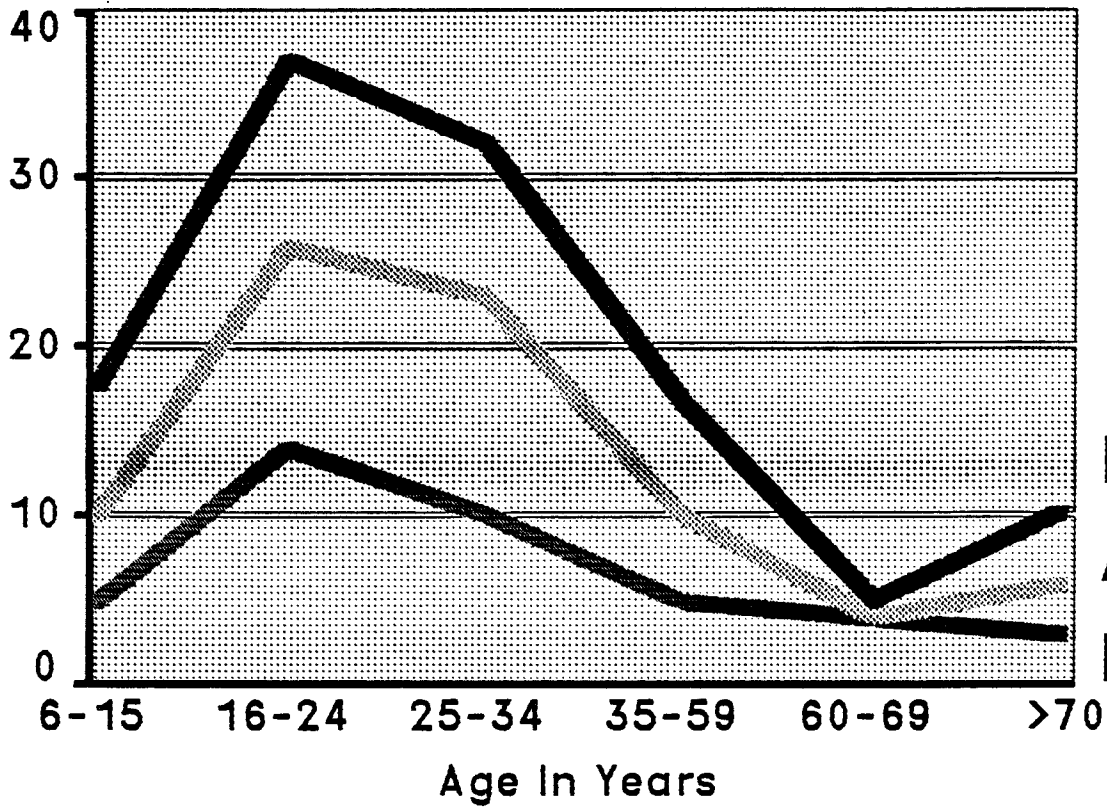
Male
Average
Female

Age In Years

ALCOHOL RELATED
AVERAGE SPEED
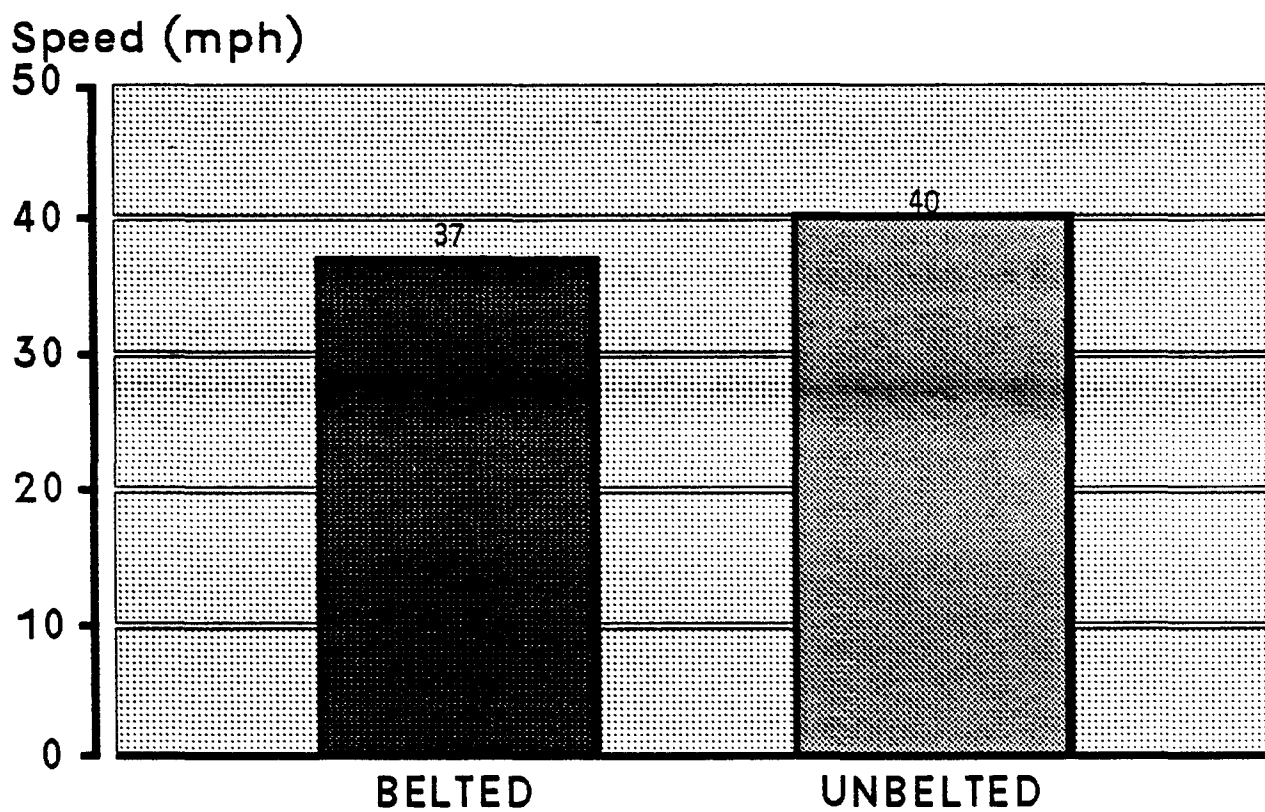
ALCOHOL RELATED
AVERAGE ISS
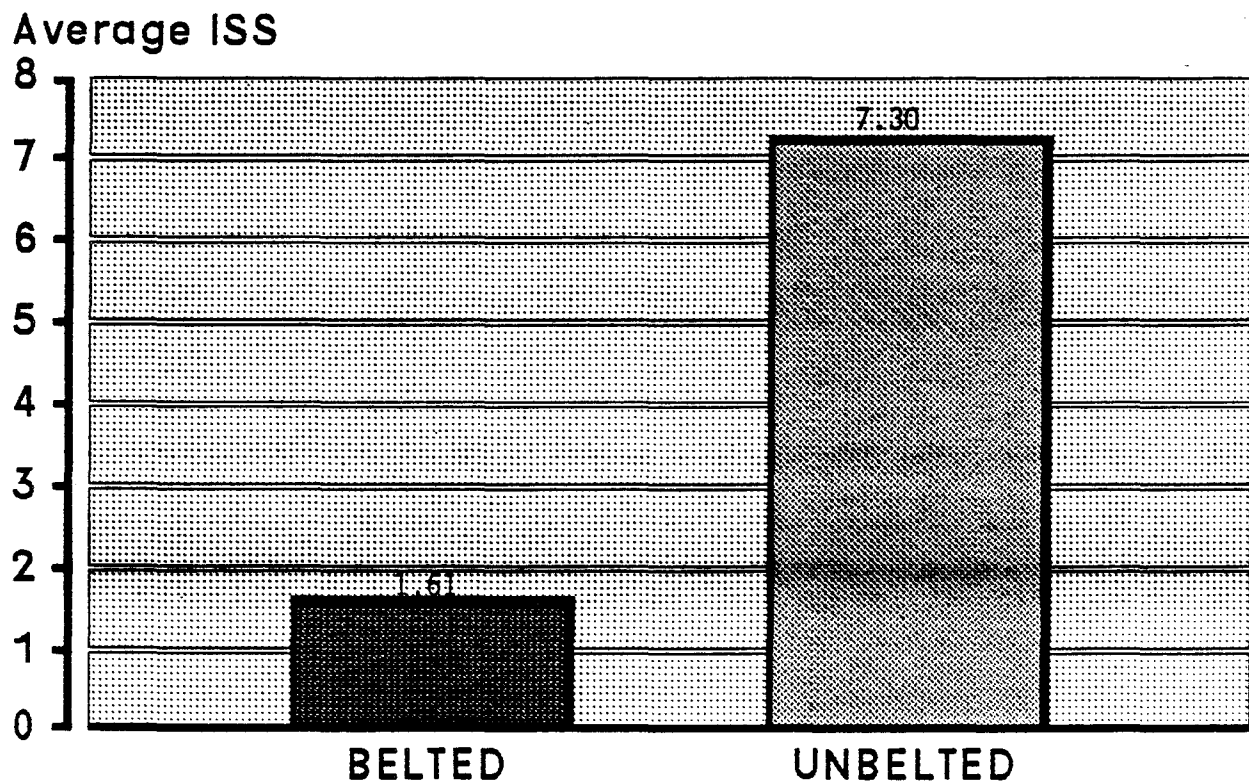
Average ISS

U:B = 4.5

For the Alcohol related victim the average injury severity
score in the unbelted is 4.5 X greater than the belted.

This ratio is over 2 X the overall study average of 2.2.

ALCOHOL RELATED
AVERAGE COSTS

Average Cost ($)
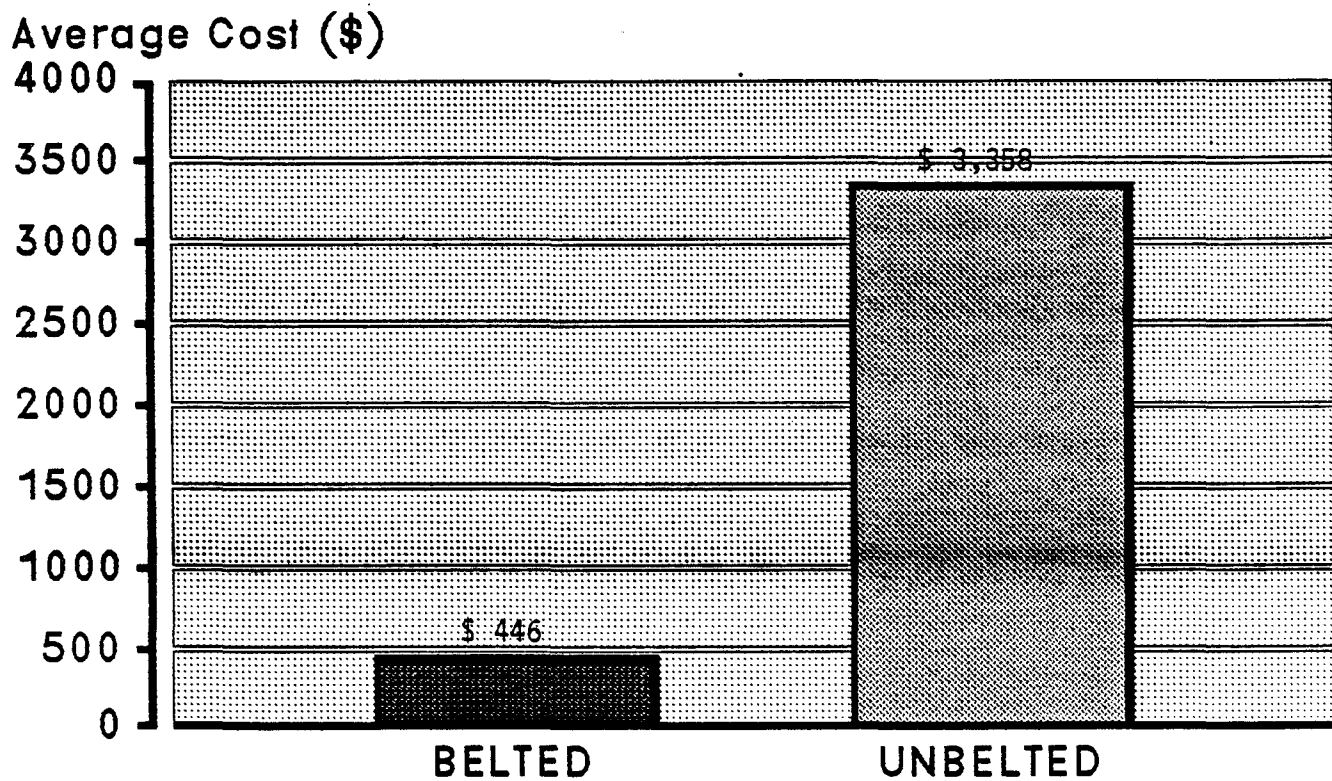
U:B = 7.5

For the alcohol related victim the average hospital bill for the
unbelted is 7.5 X greater than the belted.

This ratio is over 2 times greater than the overall study average
of 3.3.

ALCOHOL RELATED DEATHS

Number of Persons

A bar graph showing alcohol related deaths. The vertical axis "Number of Persons" ranges from 0 to 7. BELTED shows 0 deaths; UNBELTED shows 7 deaths.

EJECTION

Total Persons
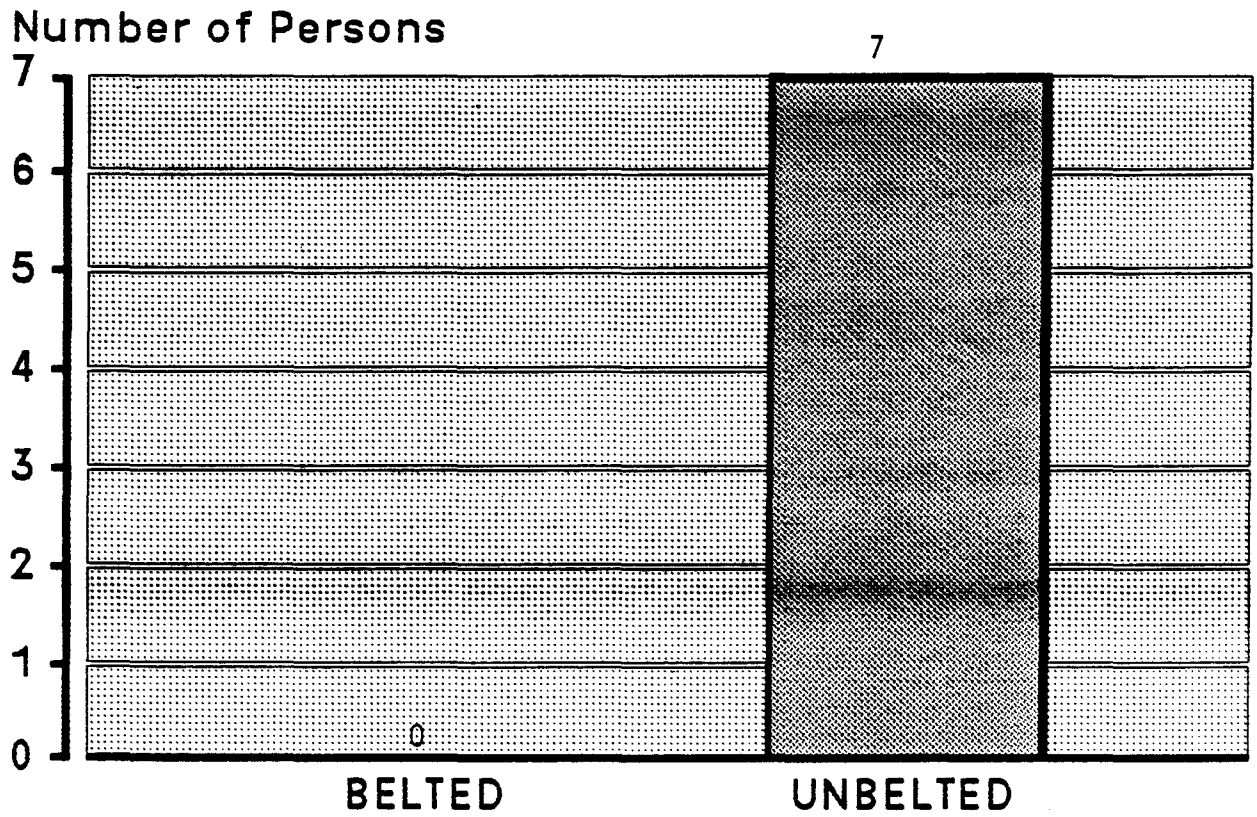
EJECTION DEFINED AS ANY BODY PART OUTSIDE VEHICLE.

(PARTIAL EJECTION = EJECTION)

BELTED WERE ALL PARTIAL EJECTION SUCH AS
HAND OR ARM ONLY.

EJECTION
AVERAGE COST

Average Cost ($)

Chart showing Average Cost ($) for BELTED ($ 920) and UNBELTED ($ 5,647), with y-axis from 0 to 6000.
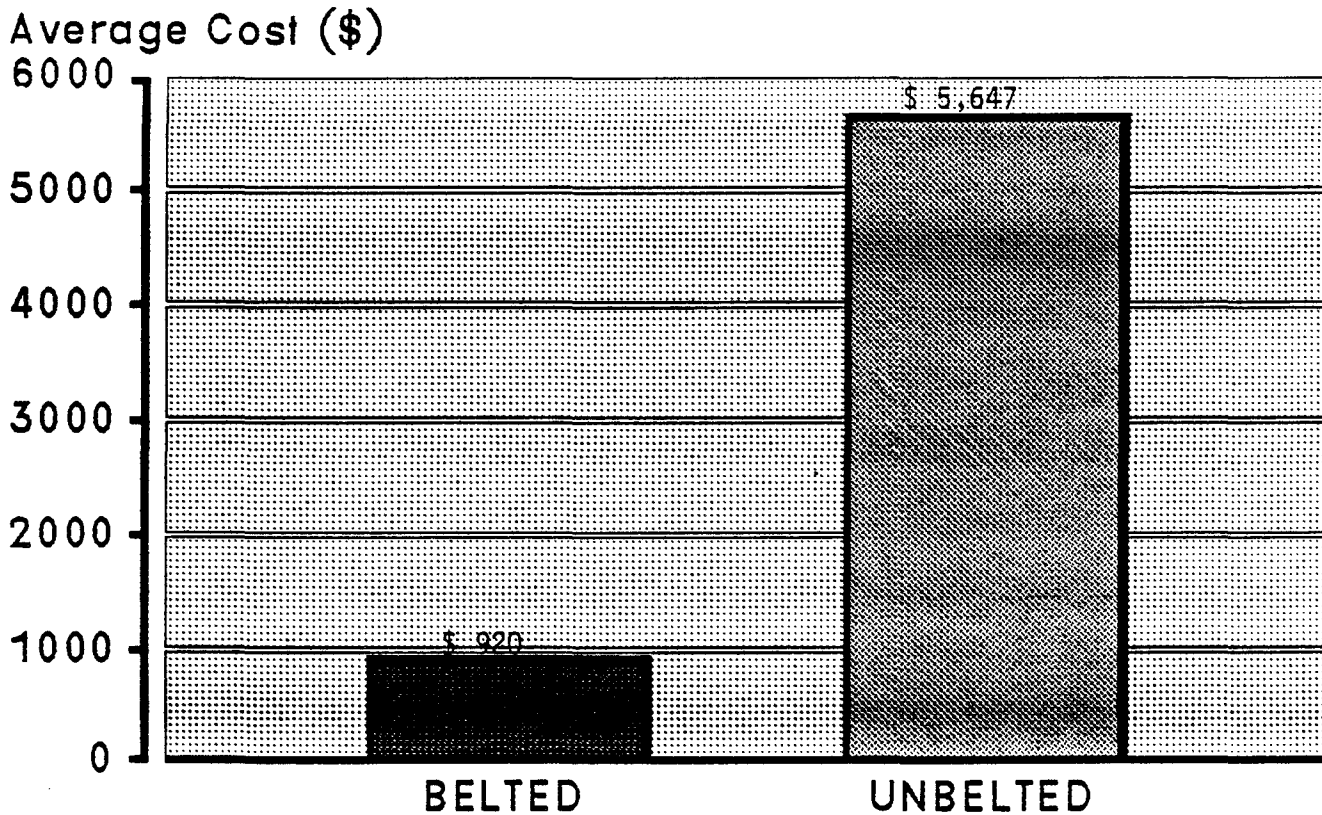
U:B = 6.1

BELTED WERE ALL PARTIAL EJECTIONS AND THEREFORE
SUFFERED LESS INJURY AND REQUIRED LESS TREATMENT.

EJECTION
AVERAGE ISS
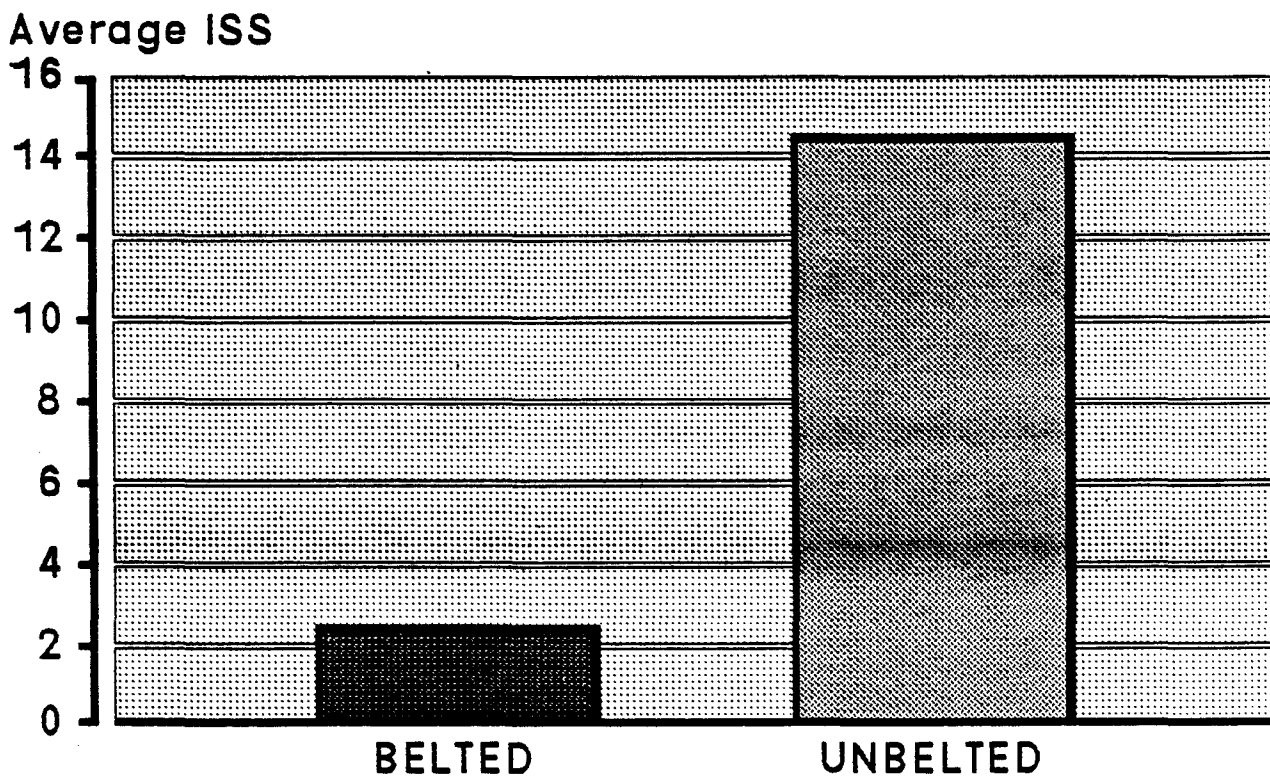
Average ISS

U:B = 5.8

The average ISS for the unbelted was 5.8 X greater
than the belted who were all only partial ejections.

HOSPITAL ADMISSION

Percent


```
                      27.21

  9.18
```
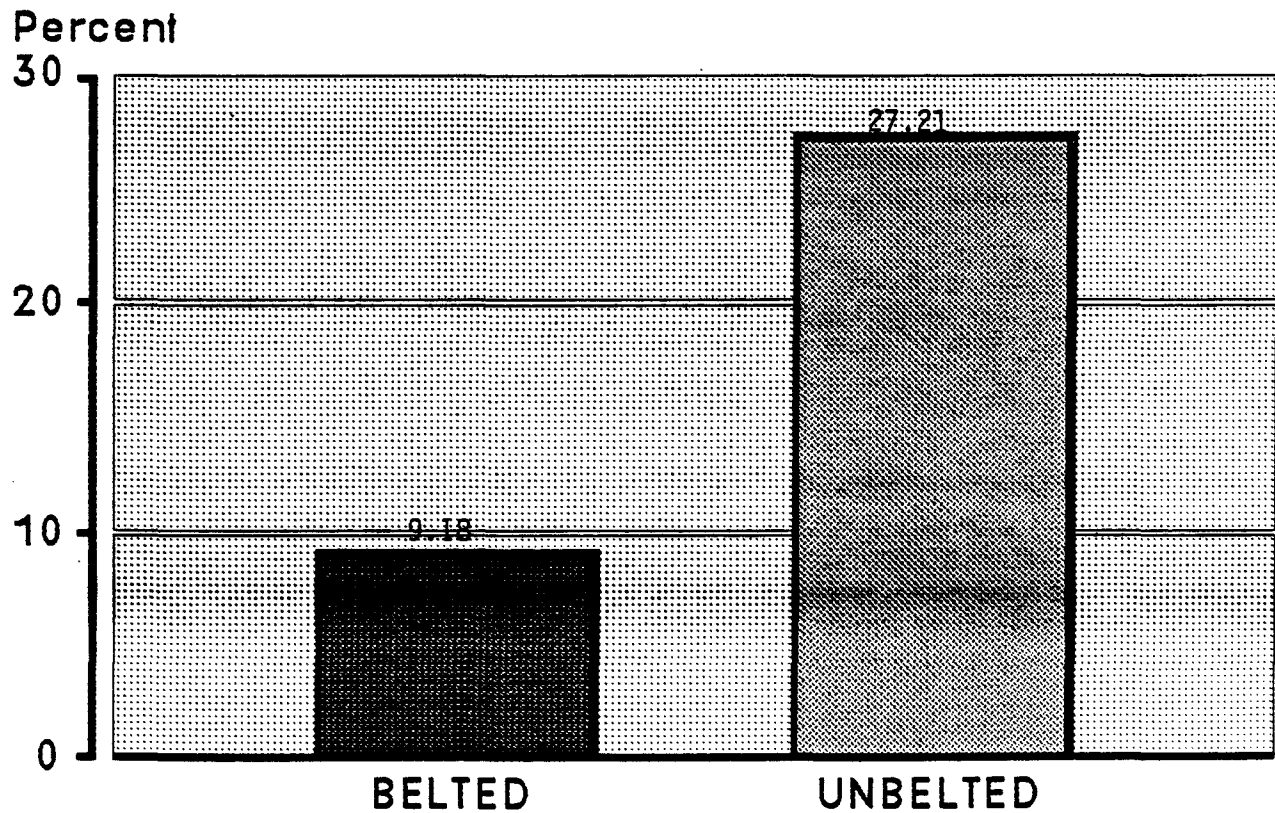
BELTED   UNBELTED

U:B = 3

Belted   =   64 persons   =   9.18%

Unbelted = 206 persons   = 27.21%

The average length of stay for the belted was 7 days and
unbelted was 17 days.

AVERAGE HOSPITAL BILLS

Dollars

A bar chart comparing average hospital bills. The y-axis shows Dollars from 0 to 3000 in increments of 500. The BELTED bar reaches $ 753. The UNBELTED bar reaches $ 2,462.
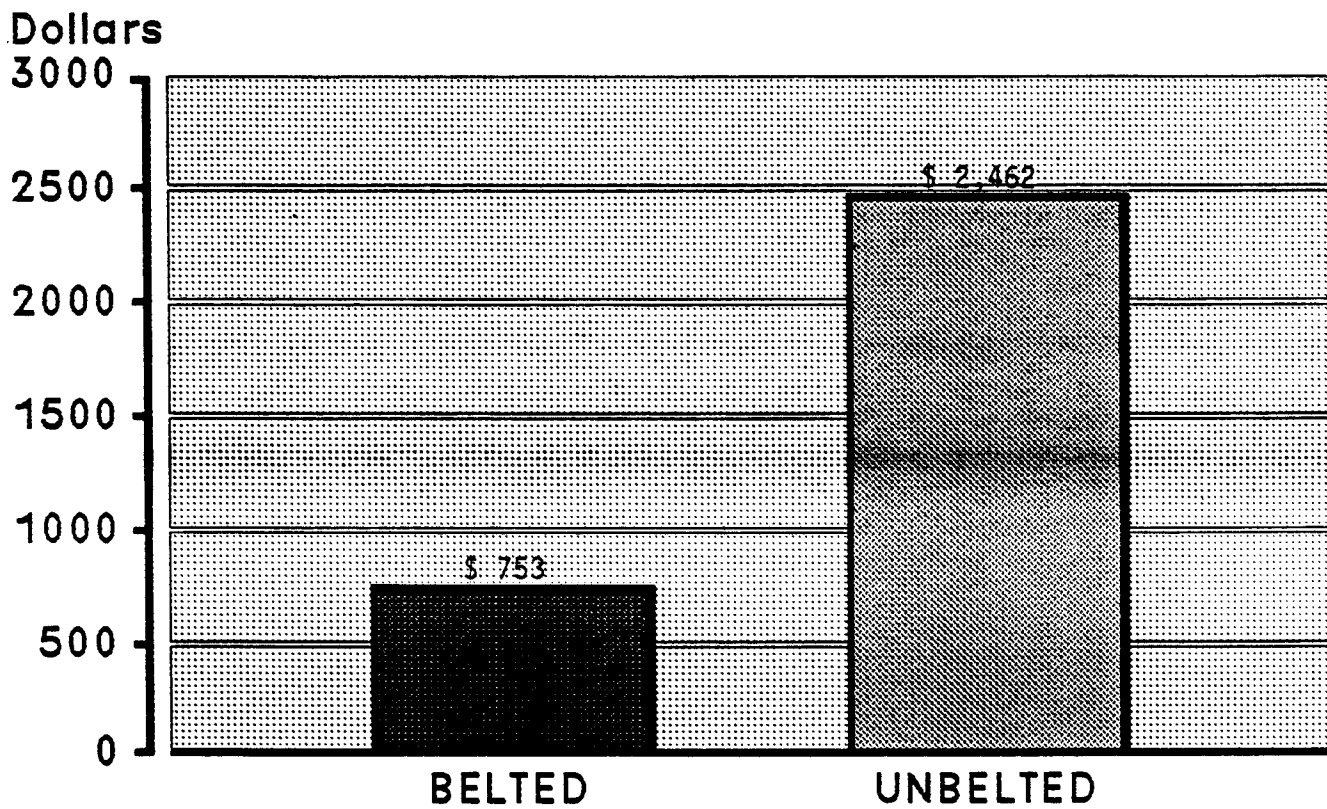
U:B = 3.3

The average hospital bill in the unbelted is 3.3 X greater than for the belted.

AVERAGE HOSPITAL BILL AT IMPACT SPEEDS, BELTED AND UNBELTED

Avg. Hospital Bill ($)

UNBELTED

BELTED

Speed (mph)
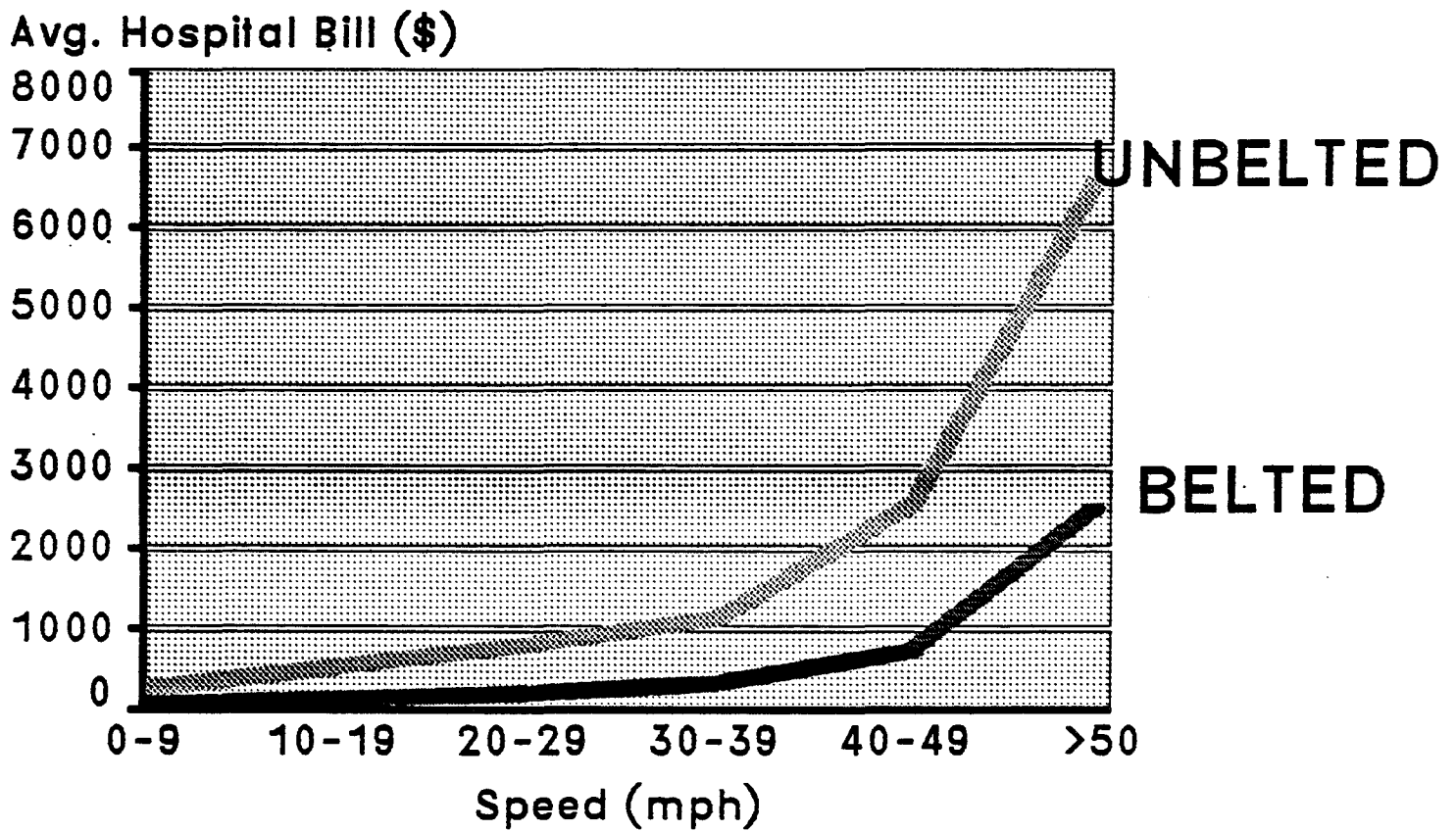
COST RATIO
UNBELTED: BELTED

Cost Ratio

Speed (mph)
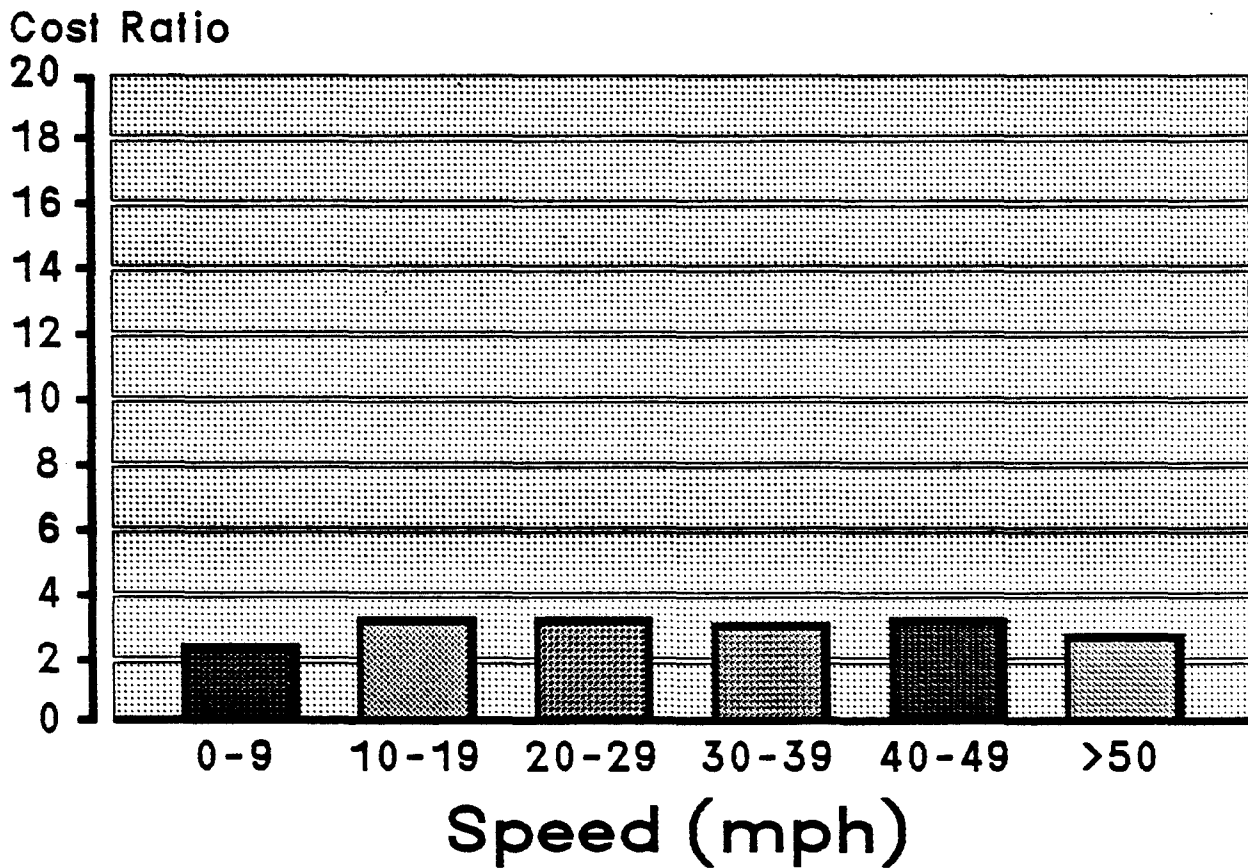
The average hospital bill for the unbelted is over 2 X
greater than for the belted at all speed ranges.

34

DISPOSITION OF ACCIDENT VICTIMS FROM EMERGENCY DEPARTMENT

Number of Persons

Bar chart showing disposition of accident victims:
- Home: Belted 630, Unbelted 540
- Admit: Belted 57, Unbelted 177
- Transfer: Belted 7, Unbelted 29
- Morgue: B=1, U=10
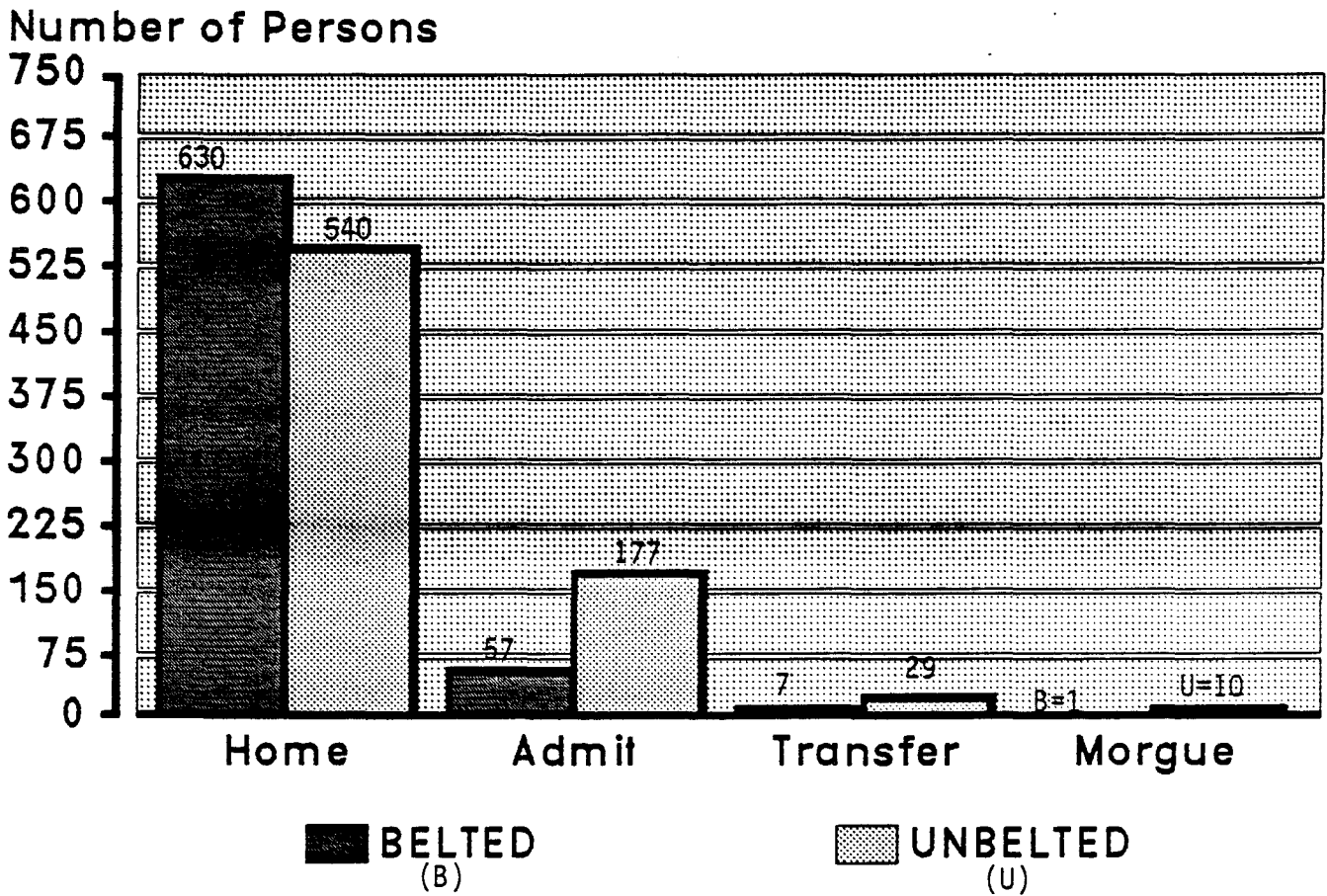
BELTED (B)   UNBELTED (U)

DISPOSITION OF VICTIMS
FROM EMERGENCY DEPARTMENT

Per Cent
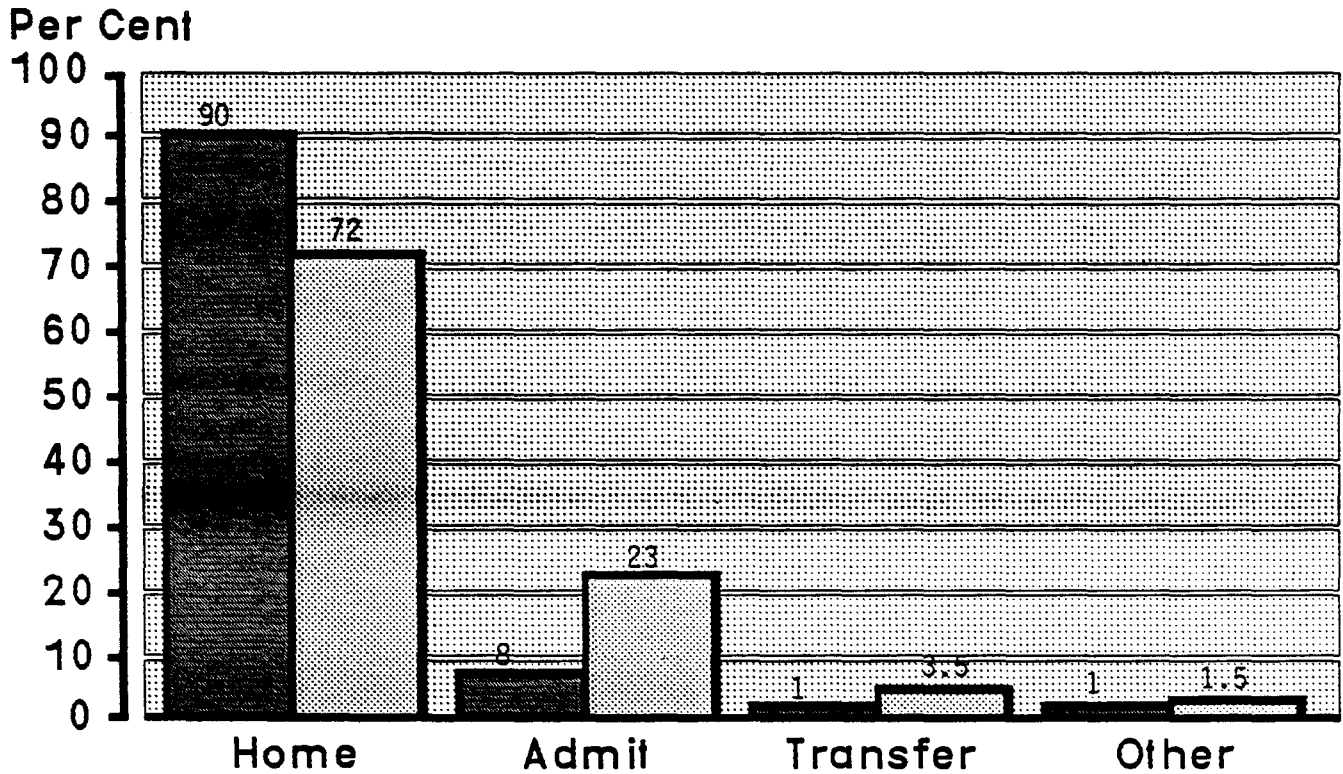
BELTED   UNBELTED

90%	HOME	72%
8	ADMIT	23
1	TRANS	3.5
1	OTHER	1.5
100%	TOTAL	100%

No Disability = Able to return to same activity as prior to crash immediately
               upon discharge from emergency department.

Temporary Disability = Unable to return to same activity for a period of time due
                       to injury from crash, however, return to same activity is
                       expected after recovery.

Permanent Disability = The injury received in the crash is expected to prohibit
                       the victim from returning to the same activity as prior
                       to the crash for the rest of their life.

DISABILITY STATUS

Number of Persons

BELTED   UNBELTED

DISABILITY STATUS

Unknown
2.7%

Temporary
33%

No Disability
64%

Permanent
.3%

BELTED

Unknown
7%

Temporary
36%

55%
No Disability
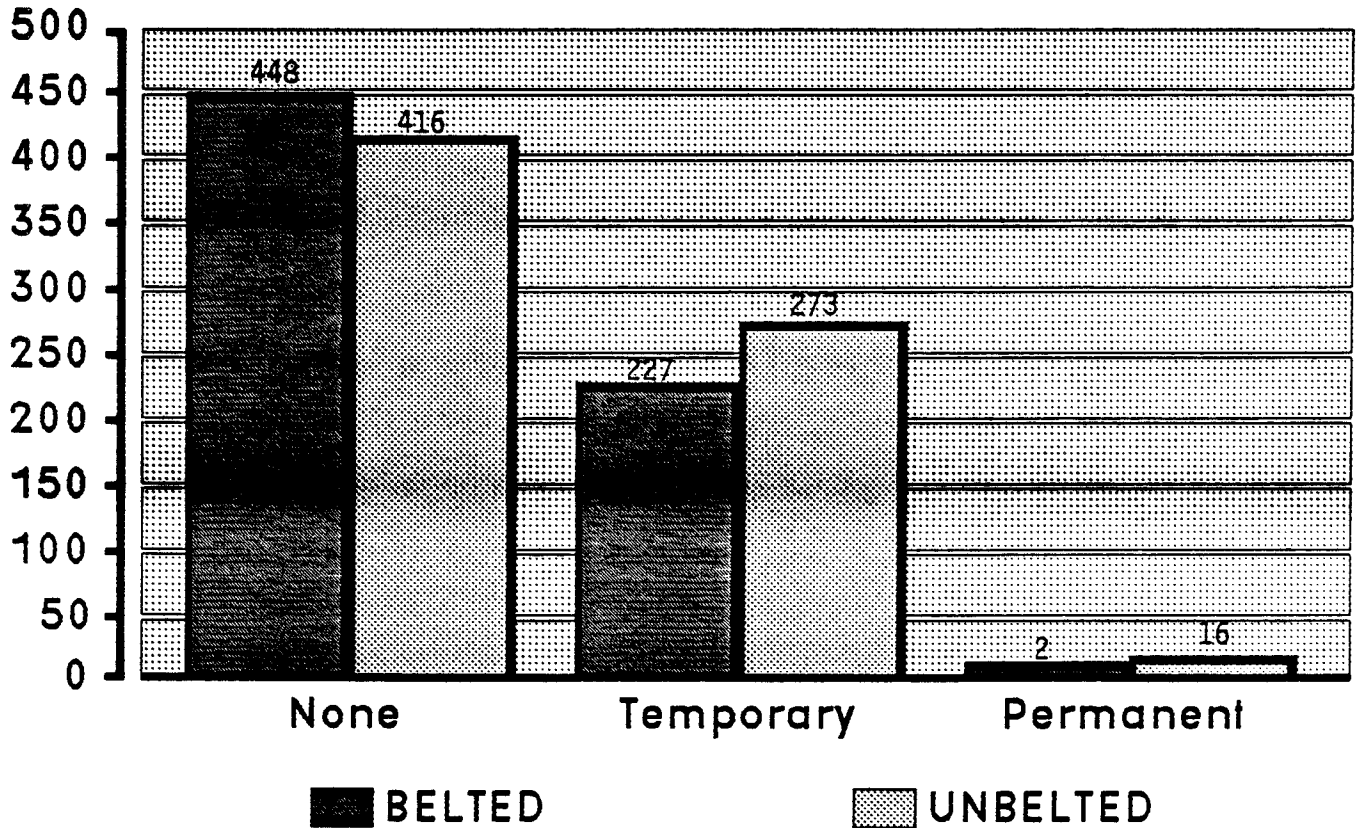
Permanent
2%
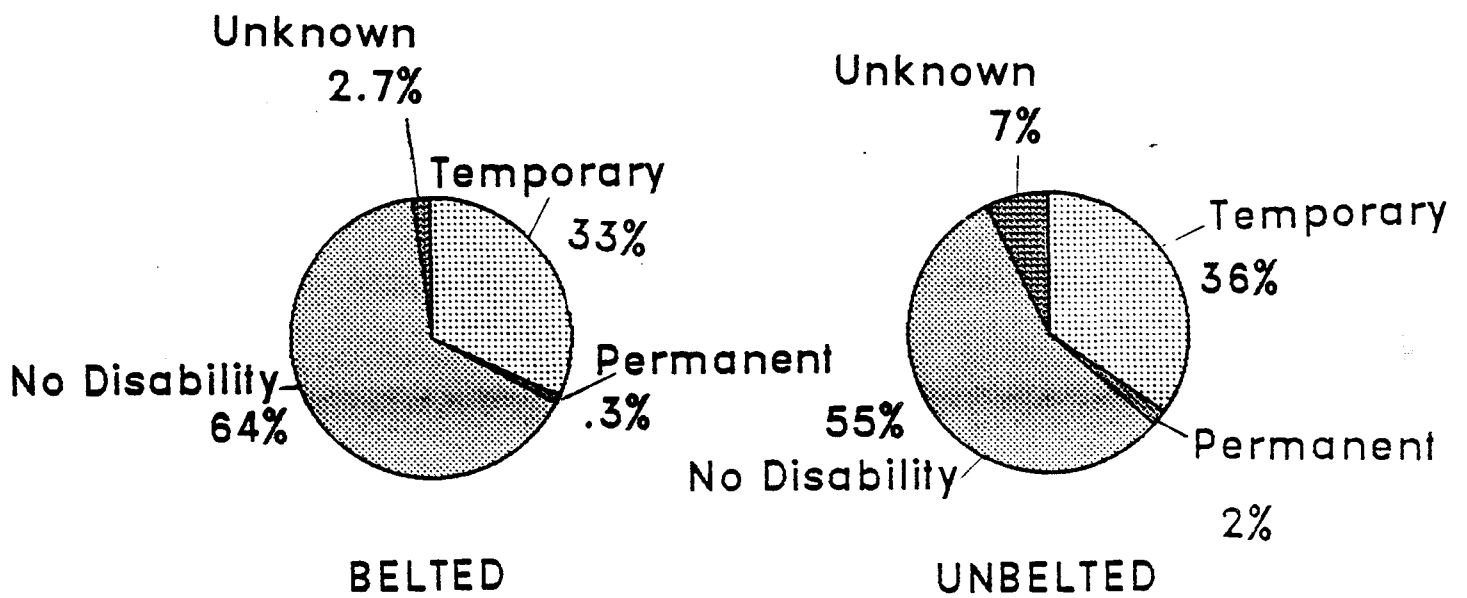
UNBELTED

Belted		Unbelted
64%	NO DISABILITY	55%
33	TEMPORARY	36
0.3	PERMANENT	2
2.7	UNKNOWN	7
100.0%	TOTAL	100.0%

Belted Permanent Disability:

1) 61 yo male driver of motor home rear-ended at about 55 mph. Seat broke
   and victim was thrown to back of vehicle. Victim suffered incomplete
   paralysis.

2) 20 month old male back seat passenger in midsize car in 40 mph frontal
   impact. He was wearing lap belt only (incorrectly restrained for age -
   should have been in child safety seat). Victim had pelvis and lumbar
   spine fractures with paraplegia.

PERMANENT DISABILITY
AND DEATH

Number of Persons

BELTED   UNBELTED
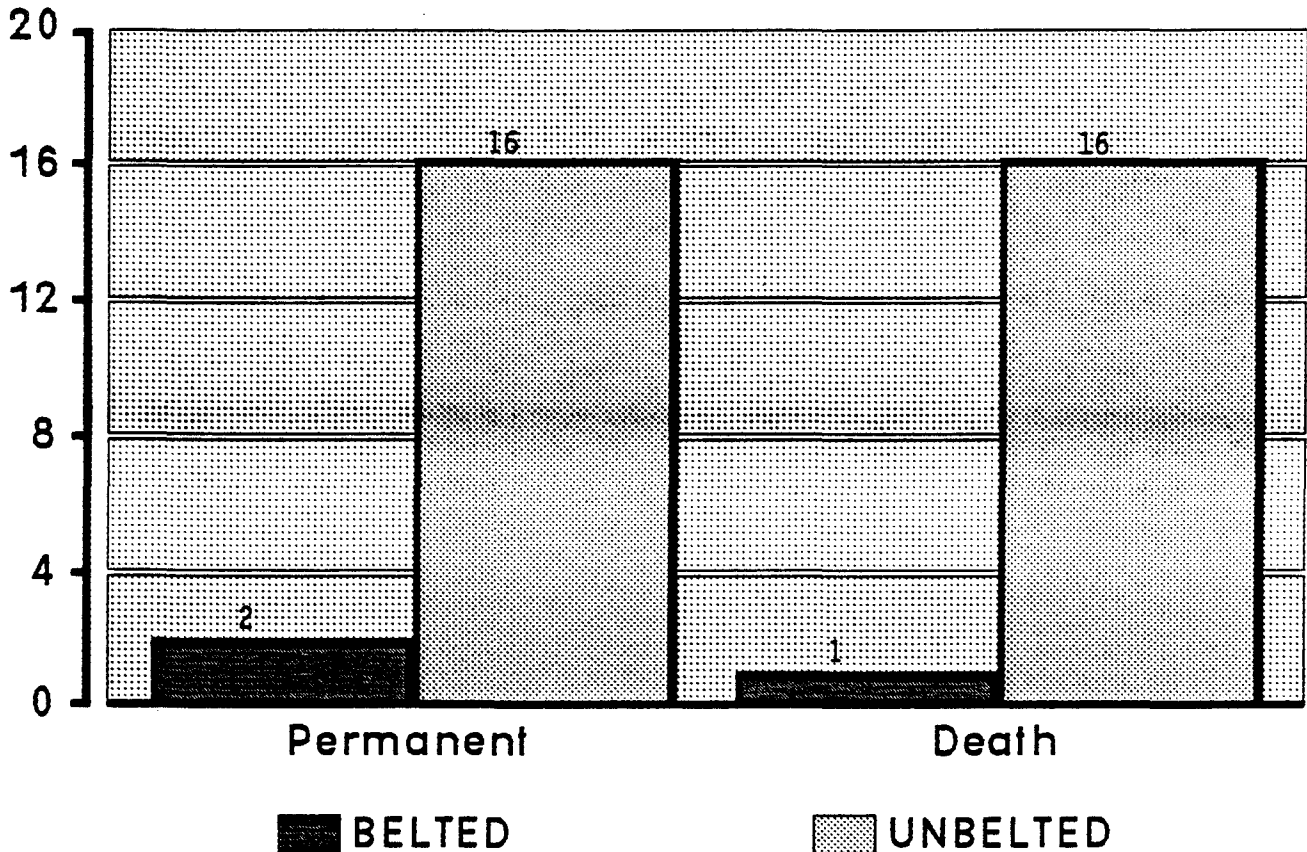
Belted Death:

1) 71 yo male driver of small car struck on driver's side at about 35 mph.
   Victim had multiple rib fractures, pneumothorax, abdominal and head
   injuries. He had a cardiac arrest in the ambulance and was prounounced
   dead in the emergency department.

DEATH

Number of Persons

	On Arrival	In Emerg. Dept.	After Hosp. Adm.
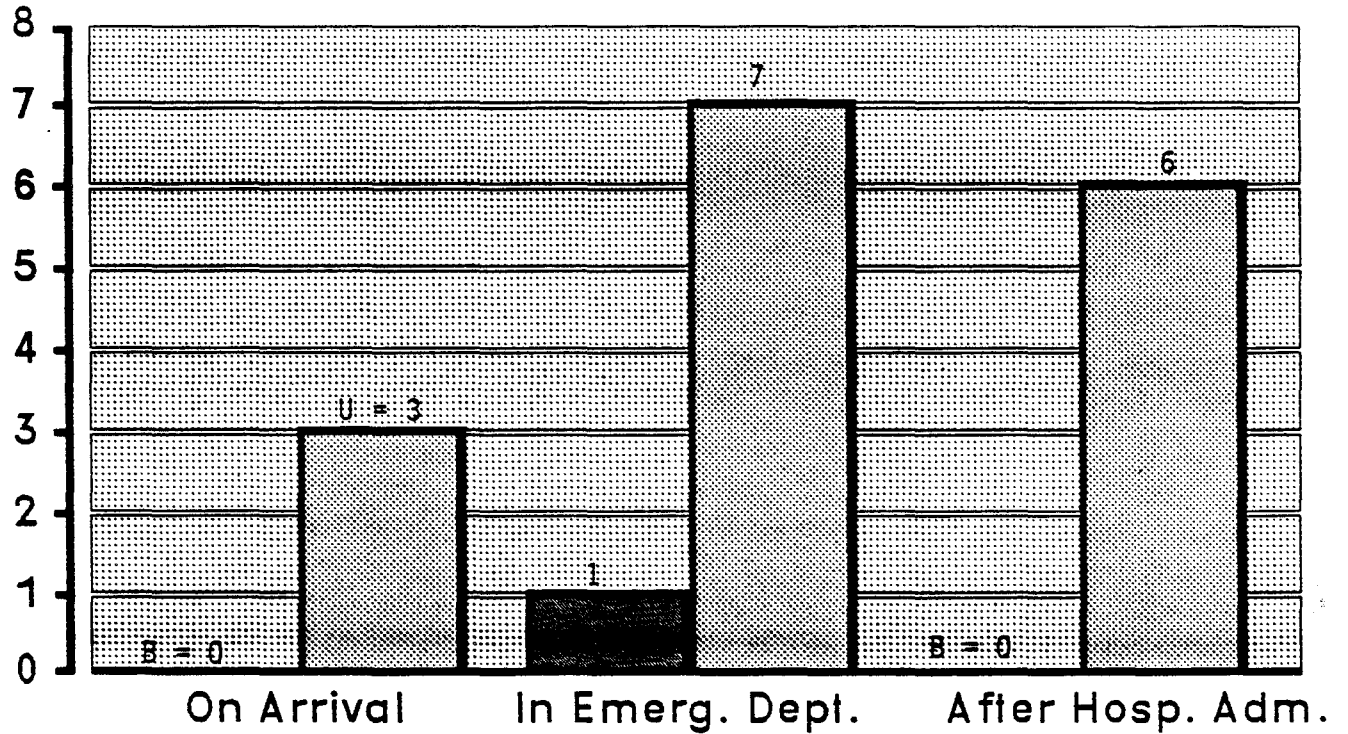
BELTED   UNBELTED

Total deaths = 17
belted = 1
unbelted = 16

DEATHS AT SPEED LEVELS
BELTED AND UNBELTED
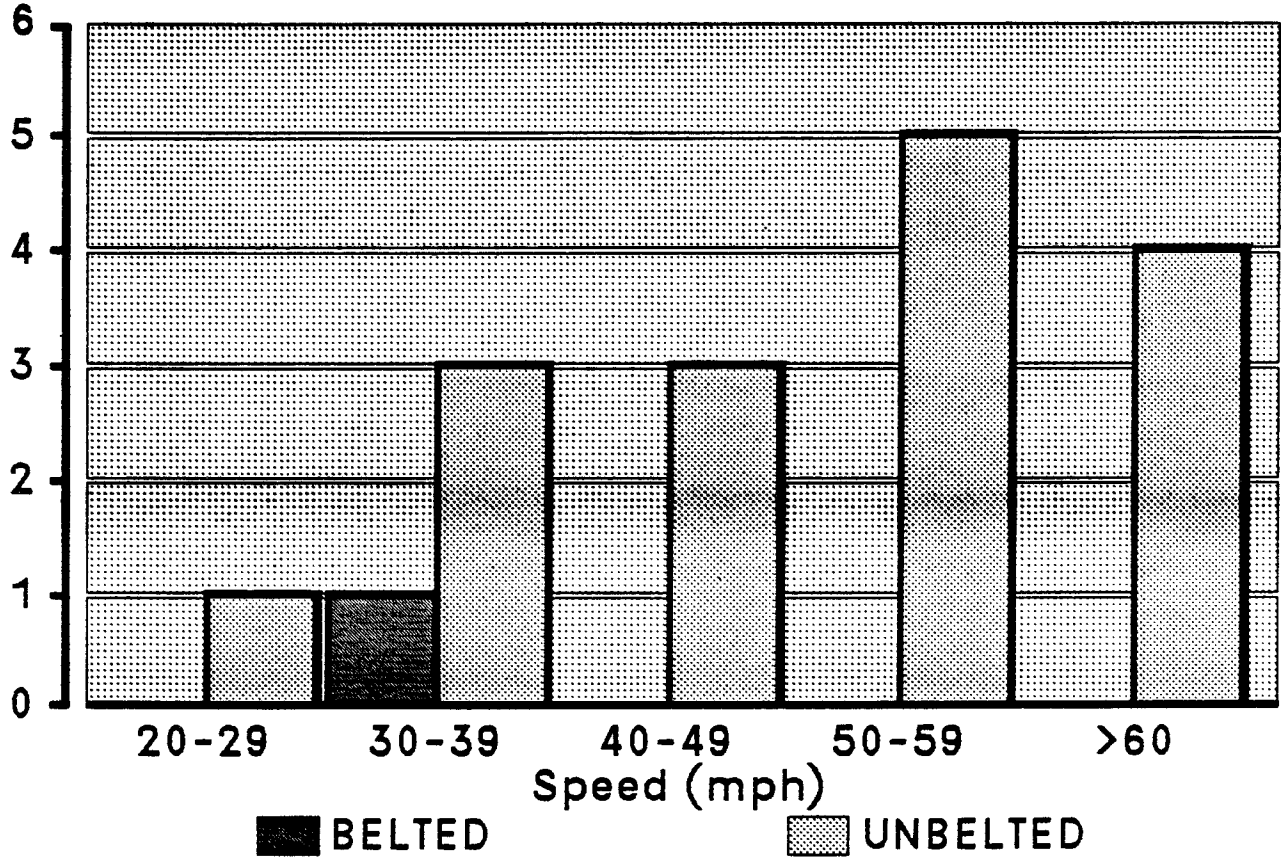
ISRA

DEATHS - AGE AND BELT STATUS

Number of Persons

Age In Years
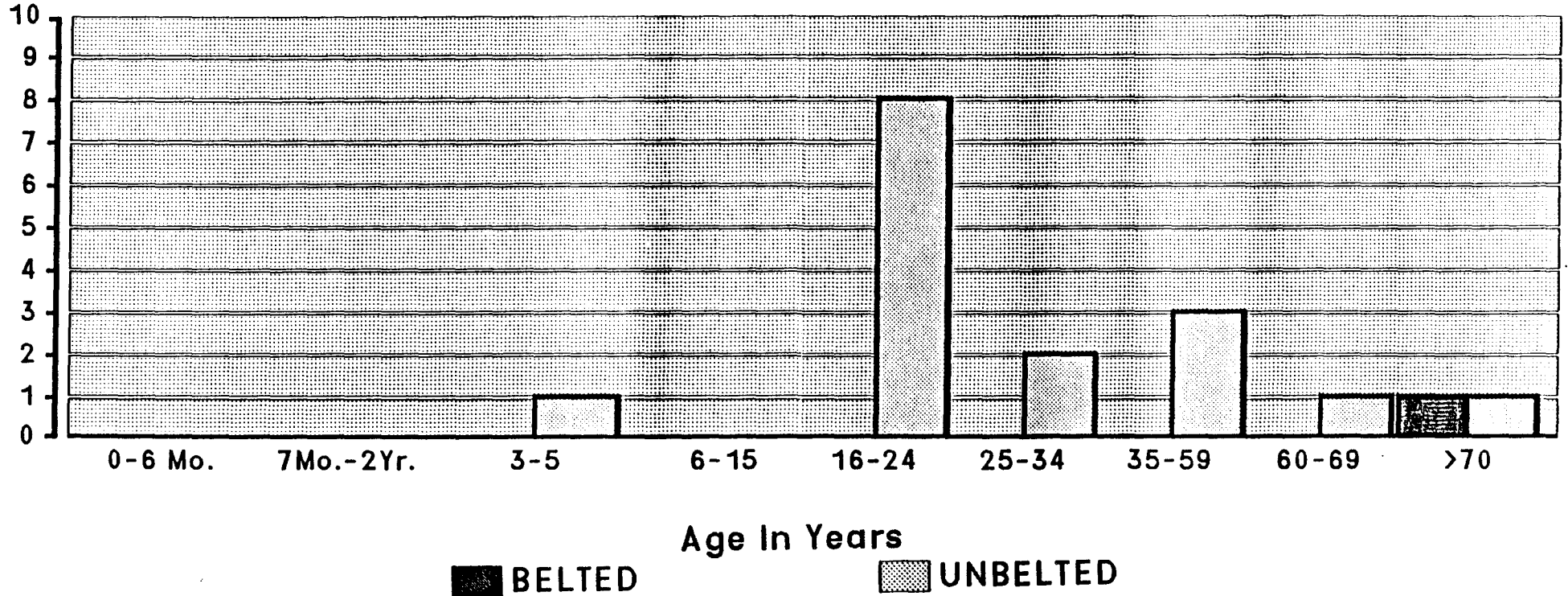
■ BELTED   ▨ UNBELTED

TOTAL DEATHS = 17

BELTED DEATHS = 1

UNBELTED DEATHS = 16

PAYMENT STATUS

COMBINED AVERAGE
(belted & unbelted)

43
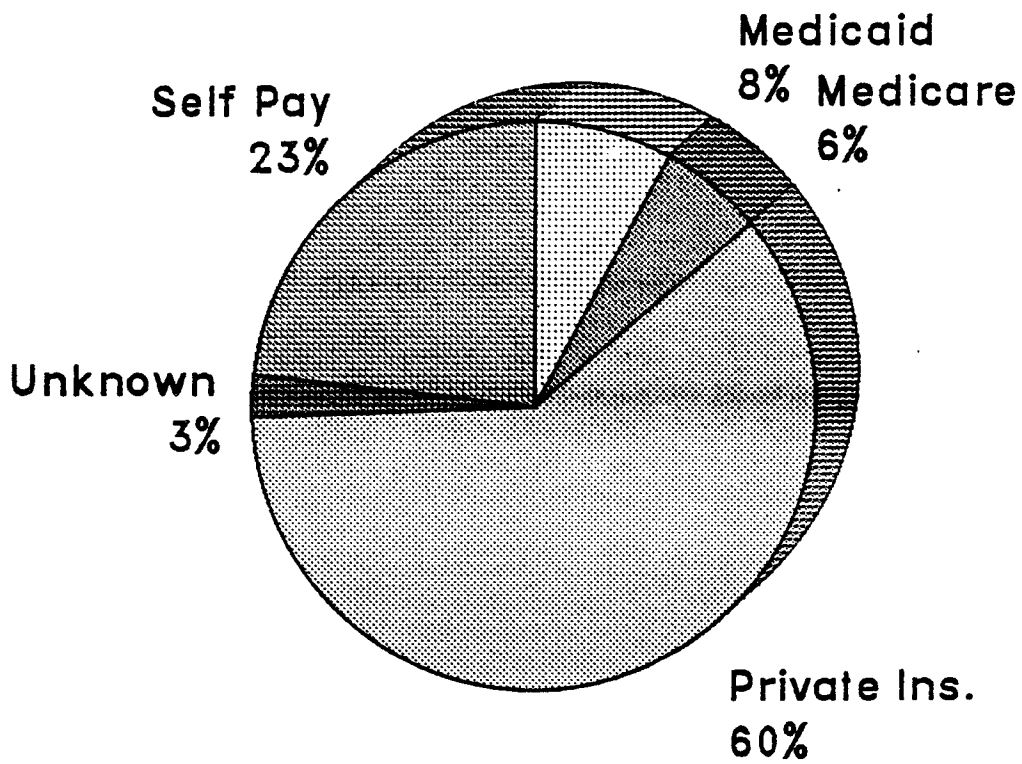
PAYMENT STATUS

Belted

Unknown 1%
Medicaid 5%
Medicare 9%
Self Pay 22%
Pr. Ins. 63%

Unbelted

Unknown 3%
Medicaid 8%
Medicare 4%
Self Pay 30%
Pr. Ins. 55%
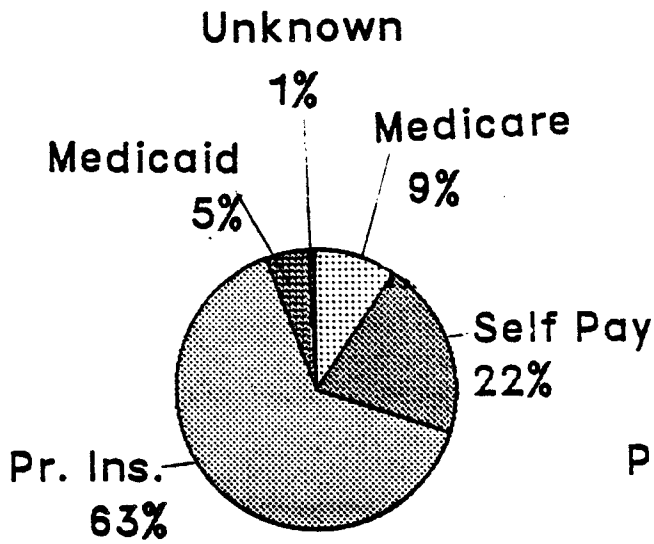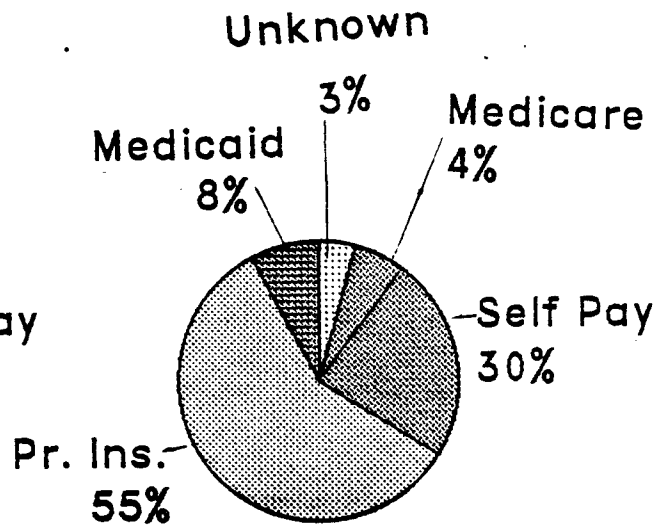
Belted		Unbelted
63%	INSURANCE	55%
22	SELF PAY	30
5	MEDICAID	8
9	MEDICARE	4
1	UNKNOWN	3
100%		100%

44

PAYMENT STATUS

Number of Persons
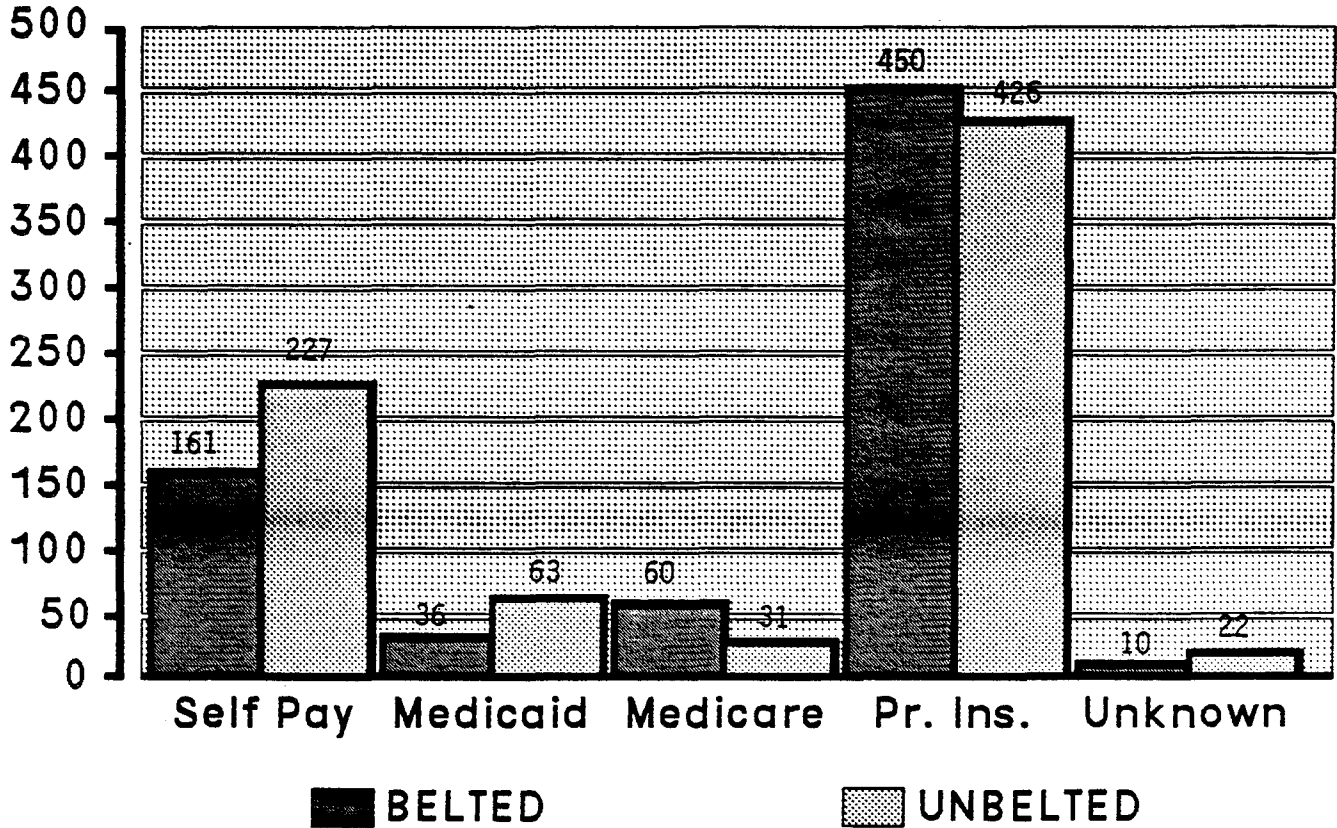
N = 1486

Some victims had more than one method listed.

DISCUSSION
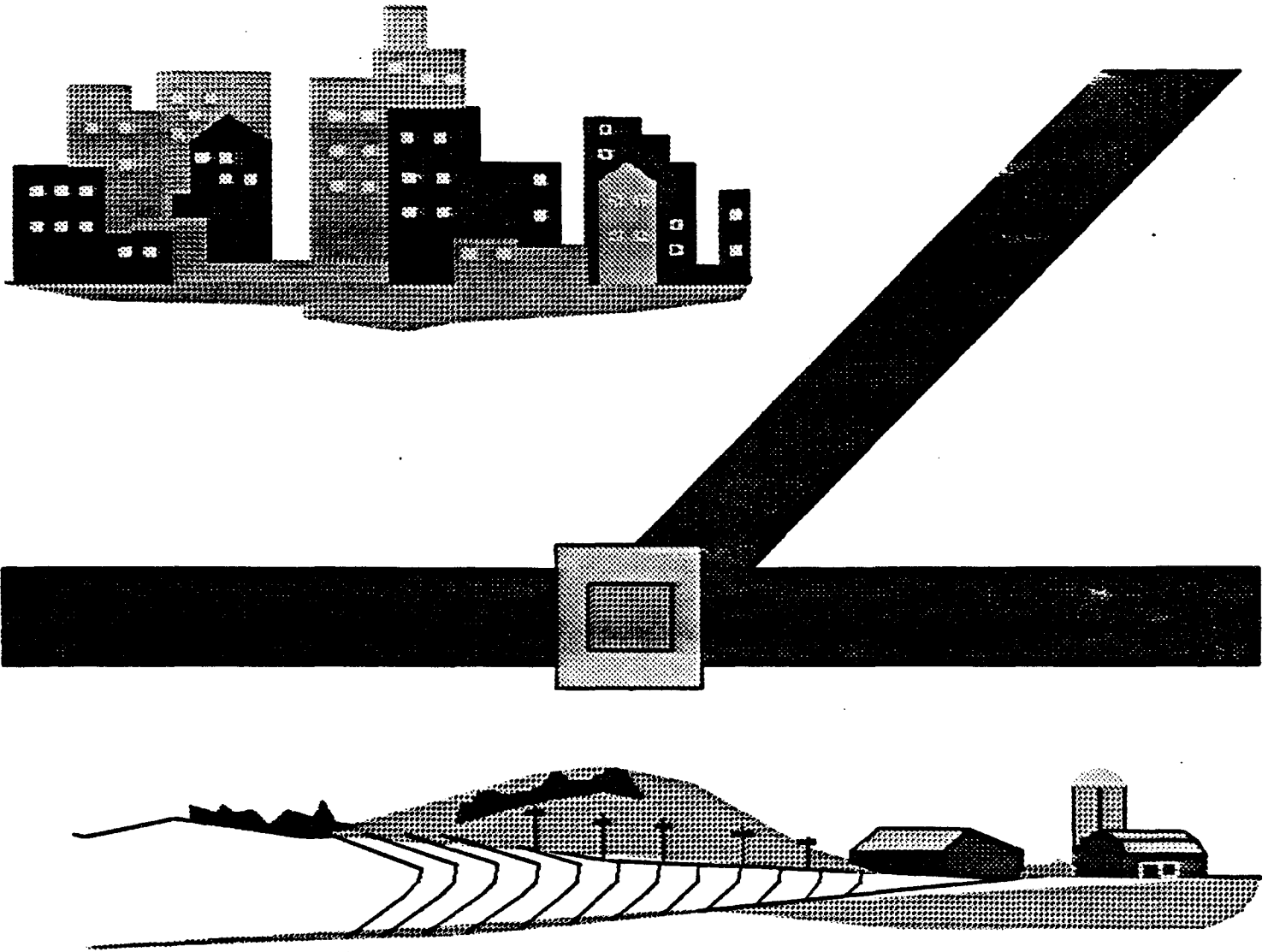
DISCUSSION

SURVEY SAMPLE:

Of the 1454 patients studied, the comparison groups were
almost equally matched in number: 697 (48%) belted (B) and
757 (52%) unbelted (B). The data collection sites were a mix
of 7 rural and 9 urban sites in all quadrants of the state of
Iowa. The hospitals included sites representing the various
levels of trauma care available in the state. The sample
size is significant in total number in that it represents at
least 20% of all crash victims presenting for care in the
state of Iowa during the survey period.

Given the large size of the sample and its statistical
stratification by hospital size and geographic area, the
sample is well representative of traffic injured persons
presenting for hospital emergency treatment in the state of
Iowa.

AGE:

Significant numbers for all age groups were included in the
study. The 16 to 24 age category represented 37% of all
crash victims presenting for care reflecting the fact that
this age group is at the highest risk for traffic accidents
and injury.

SPEED:

The average speed for the belted was 32 mph and the unbelted
was 34 mph. The speeds were mostly self reported so it is
possible that they are higher than the actual impact speed.

BELT COMPLIANCE:

As cited above, 48% of those studied were reported to be
belted. Males were belted 41% of the time and females 54%.

Age and gender differences again reflect that the 16 to 24
year old male is at high risk for injury. In this age group
males were belted only 29% of the time and females 44%.

Senior citizens had the highest belt compliance. Males were
slightly higher for ages 60 and over representing 71% and
females 67%.

INJURIES:

The average Injury Severity Score (ISS) for the unbelted was 2.2x greater than the belted (U = 4.6 B = 2.1). As the reported speed increased the ISS increased in both the unbelted and belted. The difference between the cumulative injury severity scores for the belted and unbelted was statistically significant at all levels including .005 based on a chi-square test.

The injury severity score ratio U:B was about 1.5 at speeds under 40mph then increased to 2 at 40-49 mph and to 3 at speeds greater than 50mph. Injuries in the unbelted and belted both increase with speeds, however, the belt was seen to have a continuously greater protective effect when compared to the unbelted. This is demonstrated by an increasing ISS ratio U:B as speed increases.

The more serious injuries (head injury with loss of consciousness, fracture, and laceration) were seen more often in the unbelted (significant at the .005 level by chi-square testing) as follows:

HEAD INJURY, defined as blunt injury to the head causing loss of consciousness for any length of time, was over 8 times more frequent in the unbelted. This represents 14.4% (109) of the unbelted and 1.7% (12) of the belted.

FRACTURE, defined as bone broken confirmed by X-ray, was 2.7 times more frequent in the unbelted. This represents 20.2% (153) of the unbelted and 7.5% (52) of the belted.

LACERATION, defined as a cut in the skin requiring sutures to repair, was 2.8 times more frequent in the unbelted. This represents 34.3% (260) of the unbelted and 12.2% (85) of the belted.

The total number of all injuries observed in the belted (1129, or 1.62 per person) were less than the total number seen in the unbelted (1714, or 2.26 per person). More important is the fact that for all injuries recorded there was a statistically significant (chi-square test to .005) reduction in persons with injuries in levels 1 through 5 of AIS scoring. For the AIS level 6 (maximum) injury there where no injuries recorded for the belted and thus no comparison can be made.

INJURY PATTERNS:

Patterns of injury as listed by body location according to
AIS-85 definition showed a reduction of injuries in the
categories for external, head, face, neck, thorax,
abdomen/pelvis, and lower extremity. The number of upper
extremity injuries remained about the same (U = 8.1% B =
8.3%), however, the average AIS score in this injury category
was less in the belted (U = 1.59 B = 1.16) reflecting the
fact that when upper extremity injuries occur they are less
severe in the belted.

Injuries recorded as spine according to AIS-85 definition
were almost always sprains and strains. SPRAIN and STRAIN,
defined as injury to connective tissue around a joint, was
the only injury reported more often in the belted (U = 13.9%
B = 30.0%), however, the average AIS score in this injury
category was less in the belted (U = 1.28   B = 1.05)
reflecting the fact that when injuries to the spine area
occur they are less severe in the belted.

When sprains and strains occurred they were most often the
only injury reported. Average treatment costs for patients
with this injury were relatively low with belted costs about
1/2 those of unbelted (U = $ 443   B = $ 222). The number of
persons hospitalized with this injury was much fewer in the
belted (U = 28   B = 8). It is suspected that this injury
was underreported in the unbelted who were more seriously
injured and presented with more immediate treatment
priorities.

ALCOHOL:

Alcohol related victims were reported as indicated by the
victim, police, or by clinical judgement of the emergency
department staff. Blood alcohol levels were not determined.
It is expected that alcohol related victims are underreported
using the above method, so the following findings are
undoubtedly a conservative estimate.

Findings associated with alcohol related victims observed in
this study are as follows:

    The age group most likely to use alcohol and be in a crash
    is the 16 to 24 year old. The percent of each age group
    with alcohol related injury peaks for both males and
    females in this age group, with males 2.6 times more often
    than females (M = 37% F = 14%). Interestingly this is
    the same age range with the lowest belt compliance and
    shown to be at greatest risk for injury by many studies.

Belt compliance is seen only 22% of the time representing
57 of the 257 victims. Thus the alcohol user is about
2.2 times more likely to be unrestrained compared
to an overall 48% compliance seen in the study.

The average Injury Severity Score (ISS) for the unbelted
alcohol related victim (7.3) is over 2 times greater than
for the unbelted non-alcohol related victim (3.6).
The ISS ratio for 'unbelted : belted' for alcohol is 4.5
compared to the total victim average of 2.2. This is more
than twice as much disparity between belted and unbelted
in alcohol involved accidents compared to the overall
study unbelted / belted severity ratio.

The cost for the unbelted alcohol related victim ($ 3358)
is 1.6 times greater than the unbelted non-alcohol related
victim ($ 2140). The cost ratio for 'unbelted : belted'
for alcohol is 7.5 (U = $ 4458 B = $ 446) compared to the
total victim average of 3.3, a difference of over 2 times
greater cost associated with alcohol use in combination
with non seat belt use.

Of the 17 deaths seen in the study 41% (7) were reported
to be alcohol related, all these unbelted.

HOSPITALIZATION:

Hospital admission for treatment was required 3.2 times more
often in the unbelted (significant at the .005 level by chi-
square testing). This represents 27.5% (206) of the unbelted
and 9.2% (64) of the belted. Admission included transfers to
another facility for care were 36 persons (U = 29 B = 7).

The average length of hospital stay in the unbelted was 2.4
times longer: an average of 17 days unbelted, 7 days belted.

MEDICAL COSTS:

The average hospital bill (excluding physician, ambulance,
and rehabilitation charges) was 3.3x greater in the unbelted
(U = $2462 B = $753). This is significant by chi-square
testing at the .005 level.

ESTIMATED HOSPITAL BILL REDUCTION FROM INCREASED BELT USE:

An estimate of the additional acute care hospital charges
that would have accrued in the state of Iowa during 1988 had
the compliance rate been 18% as was measured in August 1985
is calculated as follows:

Actual hospital bills at 48% compliance seen in the Iowa
Safety Restraint Assessment are (B = 697 U = 757):

```
    Belted   = $753  x   697 = $    524,841
    Unbelted = $2462 x   757 = $  1,863,734
                               ------------
                               $  2,388,575
```

Estimated hospital bills at 18% compliance (B = 262 U = 1192)

```
    Belted   = $753  x   262 = $    197,286
    Unbelted = $2462 x  1192 = $  2,934,704
                               ------------
                               $  3,131,990
```

Estimated 5 month savings seen at ISRA hospitals:

```
                      $  3,131,990
                    -    2,388,575
                      ------------
                           743,415
```

The sample conservatively represents an estimated 20% of
all crash victims presenting for care in Iowa during the
study period (about 11,000 persons are reported to be injured
during the months of November through March).

To estimate a total yearly savings in Iowa hospital bills
from a 30% increase in belt use, the above 5 month savings is
multipled by 5 (20% hospitals factor) and multiplied by 12/5
(year portion factor).

$ 743,415 x 5 x 12/5 = over $ 8.9 million

This figure does not take into consideration the portion of
those who would not present for care because they were belted
and not injured. Also, this figure does not include other
direct medical costs such as ambulance service, physician,
rehabilitation, follow-up and long term care.

To estimate the total direct medical costs would increase the
above figure by 2 or 3 times ($ 18 to 27 million). Total
indirect costs (administrative, legal, loss of income, higher
insurance rates, etc) are not a part of this estimate.

DISABILITY:

Permanent disability happened 7.4 times more often in the
unbelted (significant to .005 by chi-square testing). This
represents 2.11% (16) of the unbelted and 0.29% (2) of the
belted.

DEATH:

Death was seen 14.8 times more often in the unbelted
(significant to .005 by chi-square testing). This represents
1.72% (16) of the unbelted and 0.14% (1) of the belted. Of
the 17 deaths reported 9 were male and 8 female. The age
group 16 to 24 represents 47% (8) of these.(all unbelted
fatalities).

This study included the immediate survivors of vehicle
crashes presenting for hospital care. Those who died at the
scene were not included. Iowa has a mostly rural prehospital
emergency medical service system with long response times to
the scene. Advanced medical care is seldom available until
the patient arrives at the hospital.

CATASTROPHIC RESULTS OF INJURY:

Death and permanent disability, while observed relatively
infrequently, are clearly the most catastrophic result of
traffic crashes. For the unbelted victims who presented for
care 1 in 24 or 4.22% died or were permanently disabled. For
the belted 1 in 232 or .43 died or were permanently disabled.
Among the 1454 persons who presented for treatment in this
study, the unbelted were almost 10 times more likely to die
of suffer permanent disability resulting from traffic
crashes.

PAYMENT STATUS:

The unbelted were 1.4 times less likely to have any provision
for payment. Self pay in the unbelted was 30% (227) and the
belted 22% (161).   Those who fail to comply with the health
safety function of wearing the safety restraint are seen in
this study to be less likely to have a responsible provision
for payment. The economic disparity this creates for
hospitals and medical providers is being passed on to other
health care consumers.

CONCLUSION
&
PRESENT CHALLENGE
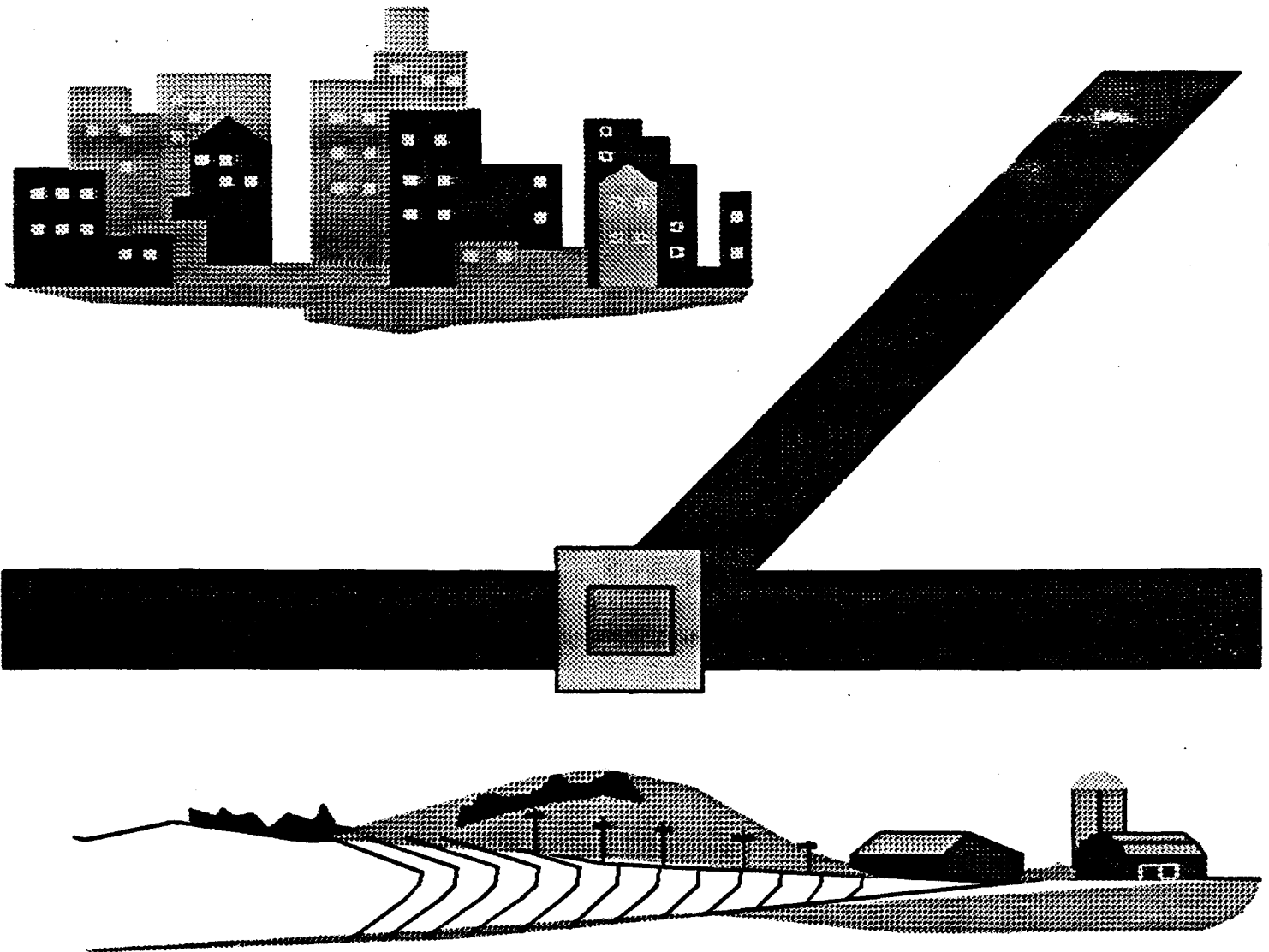
CONCLUSION

The Iowa Safety Restraint Assessment (ISRA) demonstrates a strong association of the safety restraint use with a reduction of injuries and their hospital treatment bills for occupant victims of motor vehicle crashes presenting for emergency care at a mix of rural and urban hospitals across the state of Iowa.   Crash victims using the safety restraint had a 54.4% reduction in their severity of injury, a 66.3% reduction in the need for hospital admission, and a 69.5% decrease in hospital charges.

This study supports previous findings that in America today injury is a major plague of the young. The age profile of the injured in the ISRA shows that 69% of the victims are under the age of 35 with 58% being represented by the age group 16 to 34. The age group 16 to 24 is the least likely to use the safety restraint (36% belted) and is the most frequent to be the alcohol associated crash victim (25.2% of this age group and 54.1% of the alcohol related crash victims).   Alcohol use and non-belt use are shown by this study to be risk behaviors most common in the young who also represent the largest number of the injured.

The medical costs of rehabilitation and long-term care for the disabled is beyond the scope of this study to measure. The pain and grief from injury, disability, and death is impossible for any study to measure but will be needlessly known to countless numbers of victims and their families. This study found that permanent disability and death resulting from traffic crashes to be almost 10 times greater for the unbelted.

To reduce the consequences of crash injury will require ongoing public awareness on the benefits of correct and consistent use of seat belts. Trauma and its consequences resulting from motor vehicle crashes is a major challenge to our health care system and a significant burden for society.

PRESENT CHALLENGE

The Committee on Trauma Research, Commission on Life Sciences, National Research Council and the Institute of Medicine report "Injury in America" published in 1985 clearly demonstrates injury to be the principle public health problem in the United States today in terms of cost and disabling consequences (1). But it is a problem that can be greatly reduced if adequate attention and support are directed to it.

Ways to prevent or reduce injury were initially suggested by Haddon (4) and require giving attention to the three phases of the injury event:

> 1) pre-injury event
> 2) injury event
> 3) post-injury event

Using this approach the following model is now suggested to summarize ways to minimize the consequences of crash injury. Ongoing attention to and modification through research of the following 3 crash events are required:

1) PRE-CRASH   Focus: Crash Avoidance

Method: a) road safety design
-Dept of Transportation
b) compliance to highway safety rules
-driver education
-highway safety enforcement
(speed limits, alcohol, etc.)

2) CRASH   Focus: Crash Injury Reduction

Method: a) vehicle safety design
-manufacturer

b) utilization of safety protective devices (belts, helmets, etc)
-driver and occupant education
-highway safety enforcement

3) POST-CRASH   Focus: Care of the Injured

Method: a) Emergency Medical Service (EMS) availability
-public and medical community support

b) EMS system access
-public education

c) EMS system intervention
   —medical provider education for
    appropriate care to be given
        —at scene of crash
        —enroute to hospital
        —during emergency
         department stabilization
        —for definitive surgical
         care
        —to maxamize rehabilitation

d) Trauma system standard of care
   —public policy makers
   —dispatch & provider compliance
   —hospital & system staff
    committment

e) Crash investigation and
   reconstruction by public safety
   personnel to:
       —document and report force and
        mechanism of injury to assist
        in patient care
       —determine failure of crash
        avoidance and injury reduction
        factors to enable feedback for
        implementation of prevention
        measures

The Iowa Safety Restraint Assessment has addressed a portion of the crash event and shown the benefits of the safety restraint. EFFORTS MUST CONTINUE TO EDUCATE THE PUBLIC ON THE EFFECTIVENESS OF SAFETY RESTRAINT USE WHEN INVOLVED IN A CRASH. Ways this can be accomplished are as follows:

1) The media at large and public policy must reflect the fact that correct and consistent use of the safety restraint reduces crash injury, suffering, disability, death, and direct and indirect costs.

2) Our children need to be taught at an early age the importance of buckling up.

3) The age group 16 - 24 are at the greatest risk for injury and death and must be given a special focus for preventive behavior education (safety restraint use, alcohol avoidance when driving, compliance to speed limits, etc.).

Accidental injury is a neglected problem resulting in an
unnecessary drain of productivity and health care dollars.
Injury surveillance is a vital link in understanding the
extent of this plague, in the design of interventions,
providing facts for public education, and in evaluating the
effectiveness of those changes made.

A cooperative effort to evaluate and address all aspects of
this problem - highway, occupational, home, recreational
injuries, etc - is urgently needed from the medical
community, public policy makers, state departments, and
concerned members of society. Support is long overdue for
the further development of injury surveillance and trauma
prevention activities.

Timothy Peterson, MD
Director, ISRA

R E F E R E N C E S

1) Committee on Trauma Research, Commission on Life
   Sciences, National Reaearch Council and the Institute of
   Medicine. INJURY IN AMERICA, Washington, DC: National
   Academy Press, 1985

2) Peterson, TD MD: "Trauma Prevention from the Use of Seat
   Belts", IOWA MEDICINE, Des Moines Ia, May 1987 pp 233-236

3) American Association for Automotive Medicine, Committee
   on Injury Scaling: ABBREVIATED INJURY SCALE 1985
   revision, Arlington Heights Illinois

4) American College of Surgeons, Committee on Trauma:
   EARLY CARE OF THE INJURED PATIENT. 2nd ed. Philadelphia
   Pa.: WB Saunders Company, 1976. 443 pp.
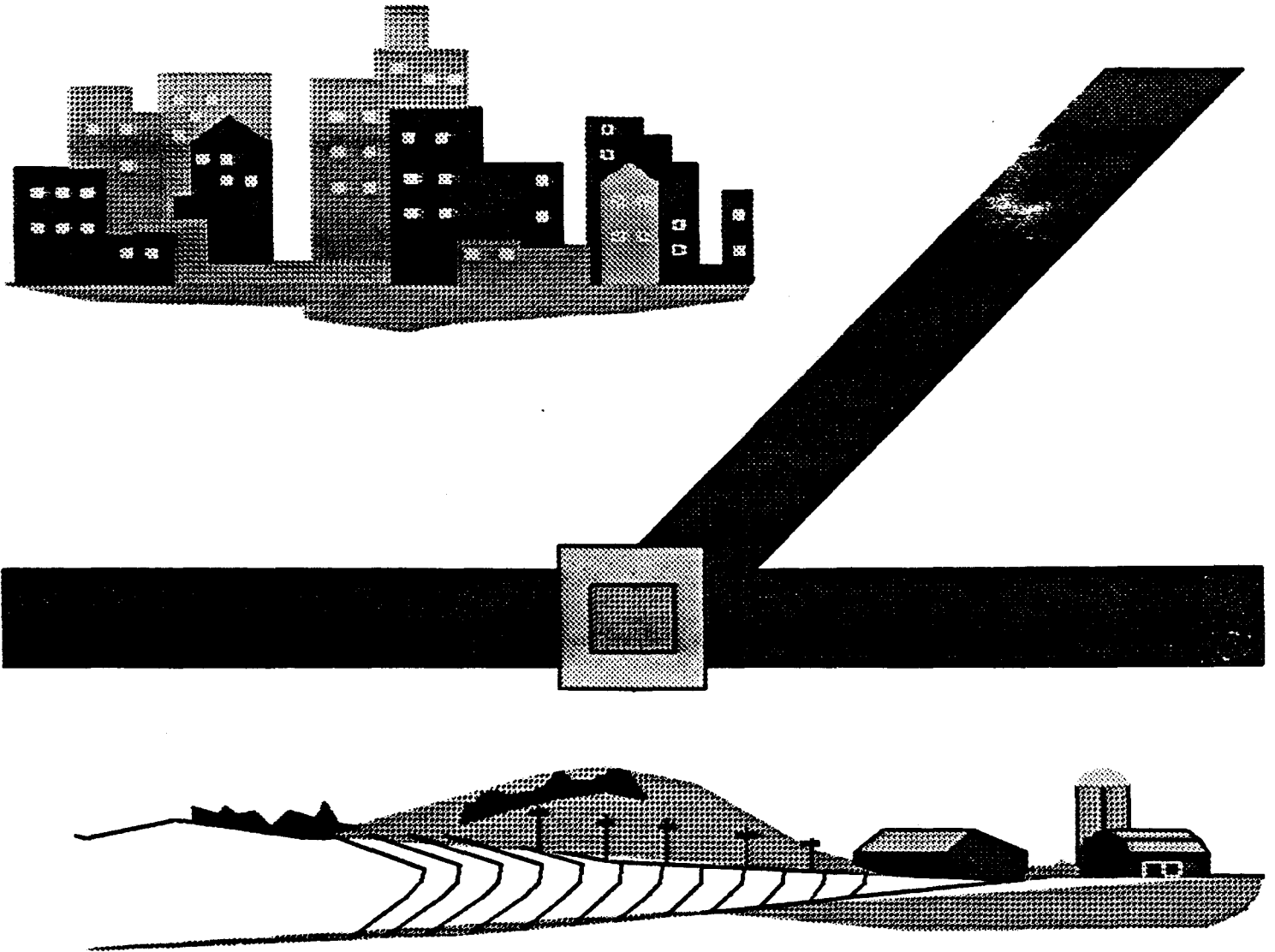
DEFINITIONS

ABBREVIATED INJURY SCALE (AIS 85): A system that codes
          single injuries and is the foundation for methods
          to assess patients with multiple injuries. Each
          injury is assigned a unique 6 digit code. The
          code includes a numeric injury severity score
          ranging from 1 to 6. (3)

ALCOHOL RELATED: Direct or indirect evidence of alcohol use
          associated with a victim in the crash.

EJECTION: The crash victim was considered to be ejected if
          any part or all of the body was found outside the
          vehicle.

HOSPITAL BILL: Charges of hospital service including
          diagnostic testing (lab & x-ray); medical,
          pharmaceutical and therapeutic treatments;
          hospital supplies; and special care unit services
          (emergency room, operating room, intensive care
          and nursing services). Not included are
          rehabilitation and follow-up costs, physician fees
          and ambulance service charges (land & air).

INJURY: Physical damage to any body part due to sharp,
          blunt, or shear force applied. Specific
          injuries are described when refered to in the
          'discussion'.

INJURY SEVERITY SCORE (ISS): A system developed by Baker to
          mathematically assign a number determined by
          adding sqaares of the highest AIS codes in each
          of the three most severely injured body
          regions. (3)

MOTOR VEHICLE ACCIDENT: An incident involving a vehicle
          licensed for travel on the state roadways
          producing damage to the vehicle and / or
          passenger(s). Included is a sudden deceleration
          event where the occupant suffers injury within the
          vehicle whether the vehicle impacts another
          external object or not.

NONCRASH INJURY: A sudden deceleration event where the
          occupant suffers injury within the vehicle
          without the vehicle impacting another external
          object.

OCCUPANT: The driver or passengers within the motor vehicle.

SPEED OF IMPACT: Estimated speed in MPH of vehicle
           immediately before impact occurred.

ISRA DATA COLLECTION FORM

I. IDENTIFYING DATA (By Registration Personnel)

Medical Record # _____   **Sex:** ☐ M ☐ F   **Age:** _____

Accident Date: ___/___/___   **Registration Date:** ___/___/___   **Arrival By:** ☐ Private ☐ Ambulance

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II. ACCIDENT DATA (By Nursing)

Approx. Speed of Impact: _____   **Alcohol/Drug Related** ☐ Yes ☐ No   **Ejected From Vehicle?** ☐ Yes ☐ No

Vehicle Type: ☐ Car ☐ Pickup ☐ Van ☐ Truck ☐ Other   **Vehicle Size:** ☐ Compact ☐ Midsize ☐ Large

Impact Location: ☐ Head On   ☐ Driver's Side   ☐ Passenger's Size   ☐ Rear   ☐ Rollover   ☐ Non-Crash

Position In Vehicle: A / B / C   **Accident Location:** ☐ Town   ☐ Country

    A. Front Seat: ☐ Driver   ☐ Middle   ☐ Passenger

    B. Back Seat: ☐ Driver's Side   ☐ Middle   ☐ Passenger

    C. Other Areas: ☐ Back of Van   ☐ Back of Truck ☐ Other

III. SAFETY RESTRAINT DATA (By Nursing)
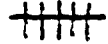
Belt Worn? ☐ Yes   ☐ No: **If Yes:** ☐ Lap Belt   ☐ Worn on Hips   ☐ Shoulder Harness   ☐ Snug

< 6 Months? ☐ In Car Seat   ☐ Facing Rear   **< 3 Years?** ☐ In Car Seat   ☐ Attached To Seat   ☐ Seat Attached To Car

< 3 years or 6 Months and Not In Seat: ☐ Held In Lap ☐ Sitting Alone ☐ Standing Alone ☐ Lap Belt

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IV. INJURIES (By Nursing)

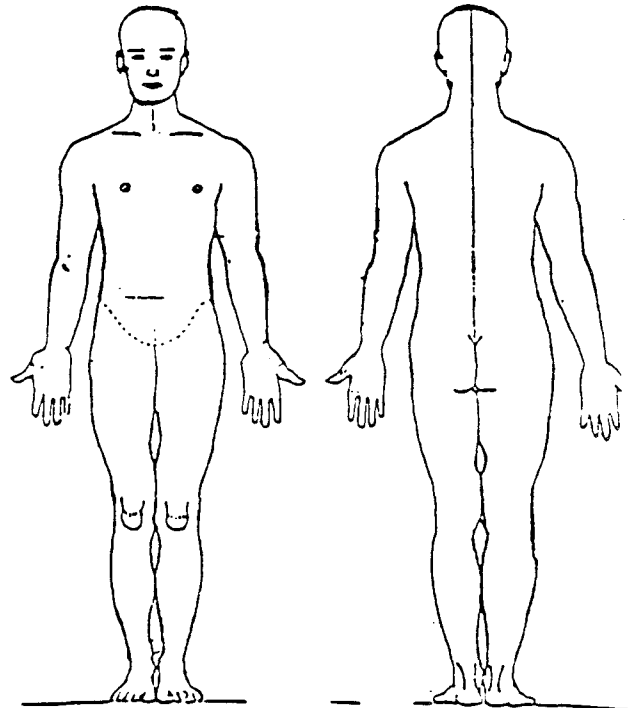### 1) Check Those That Apply.   2) Describe Severity and List Location.

☐ Abrasion

☐ Contusion

☐ Laceration

☐ Sprain/Strain

☐ Head

☐ Spine

☐ Chest

☐ Abdomen

☐ Other Injuries, List:

☐ No Injuries. ☐ Fracture

☐ Pregnant: ☐ Yes   ☐ No

3) Loss of Consciousness: ☐ Yes   ☐ No

   If Yes, Less that 15 Minutes   ☐

           15 to 59 minutes   ☐

           1 hour to 24 hours   ☐

           Longer than 24 hours   ☐

4) Other CNS Sequella List:

Comments:

V. DISPOSITION (By Nursing)   Discharge Date: ___ /___ /___

Status: ☐ Home   ☐ Admit   ☐ Transfer
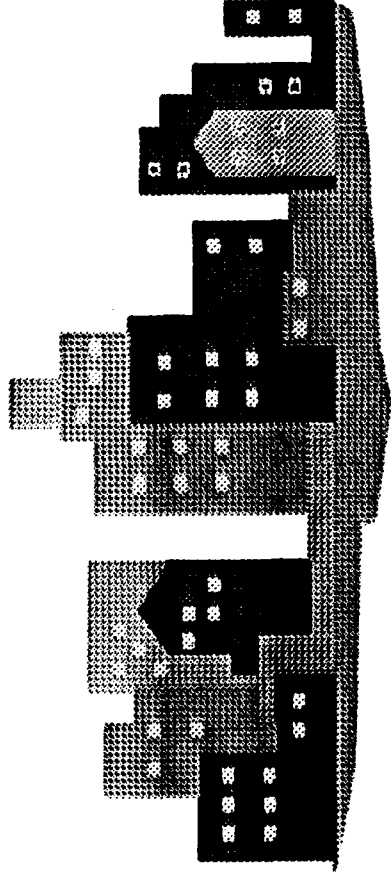
Function: ☐ Pre-Injury Capacity   ☐ Temporary Handicap   ☐ Permanent Handicap

If Expired: ☐ D.O.A.   ☐ Emergency Dept. Death   ☐ Hospital Death

If Transferred, Receiving Hospital: Name _____ Location _____
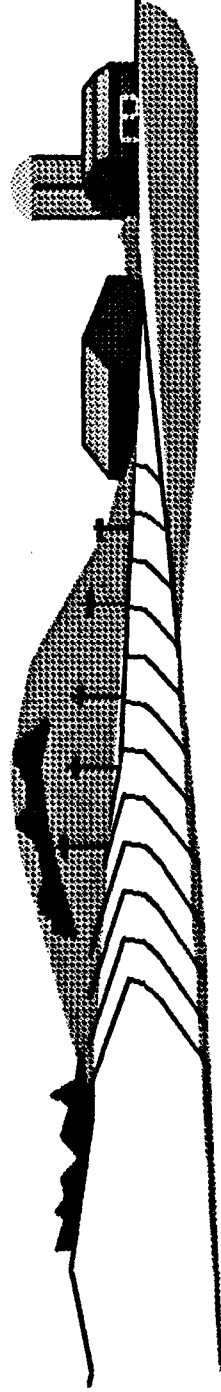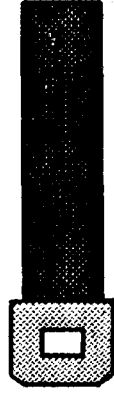

VI. PATIENT CHARGES (By Billing)

Total Hospital Charges $_____   **Payment Sources:** ☐ Self Pay   ☐ Insurance   ☐ Medicaid   ☐ Medicare
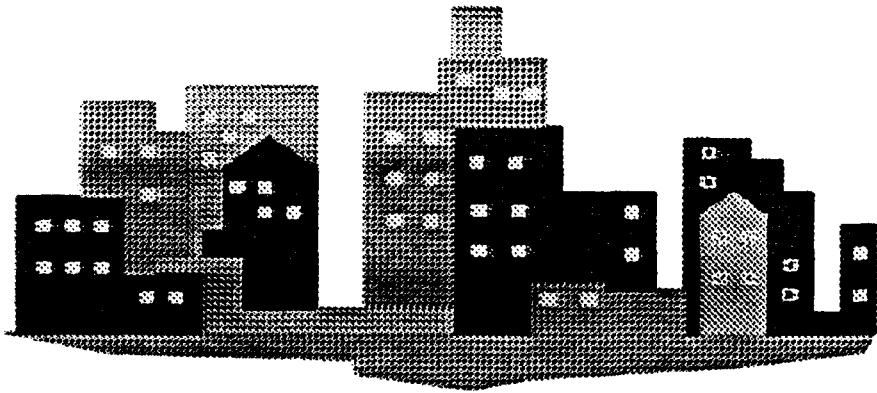
Iowa Safety Restraint Assesment

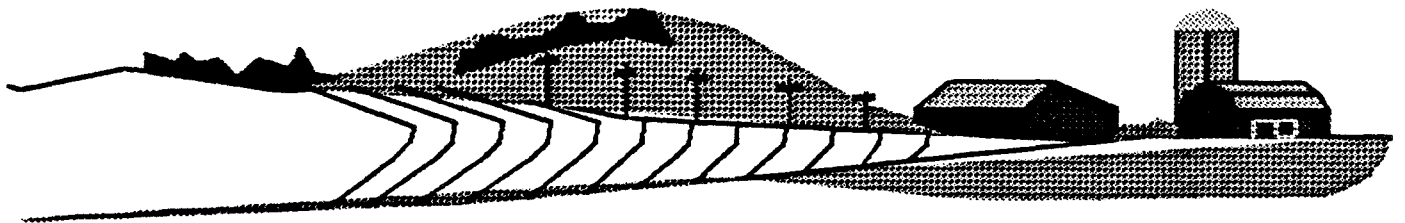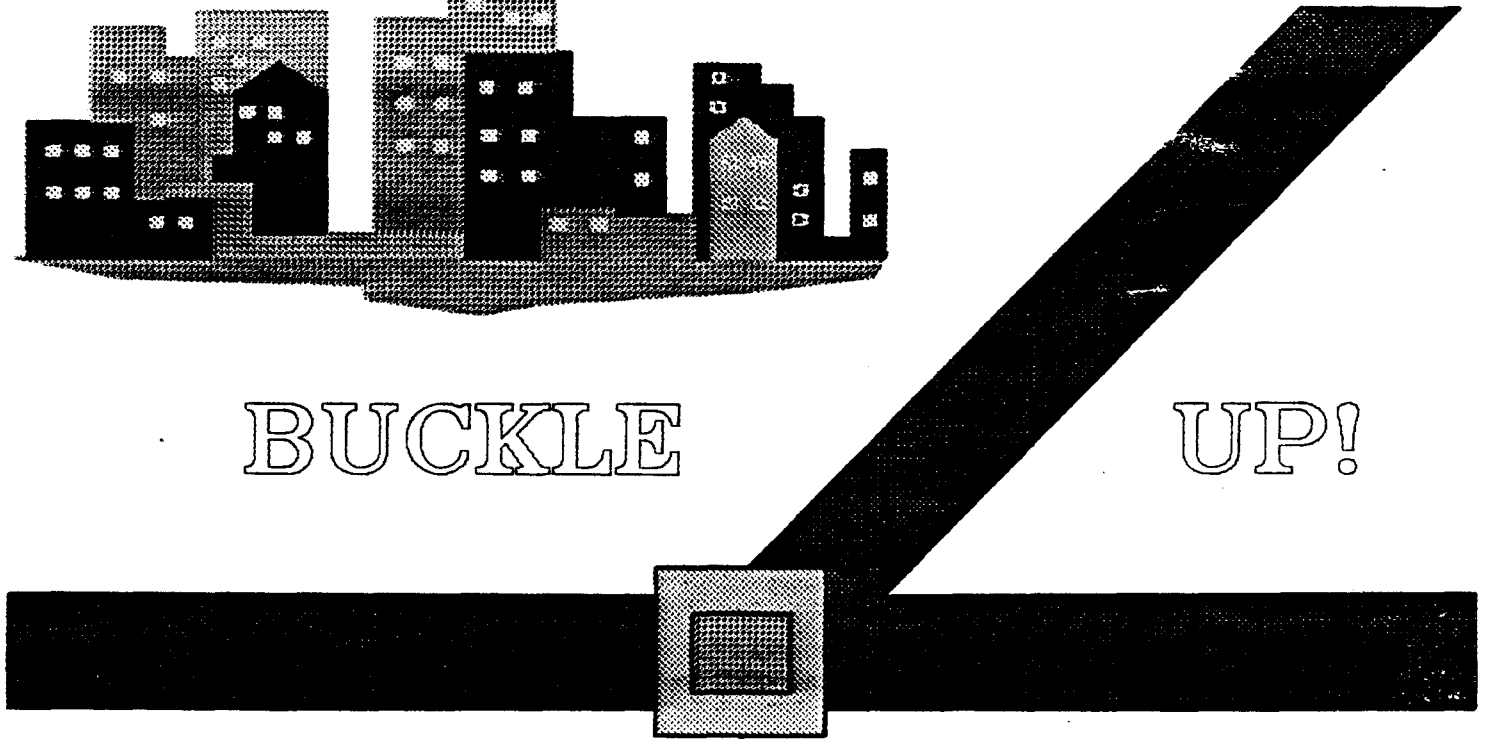BUCKLE   UP!