# BLOOD ALCOHOL CONCENTRATIONS OF PEDESTRIANS

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**Abstract**

BACs were obtained for 213 adult pedestrians who were admitted to an Adelaide hospital between August 1985 & July 1987. Almost 2/3 of the pedestrians were male, and males had a higher rate per 10,000 pop. of admission to hospital than female pedestrians. Overall, 38% of the pedestrians with known BACs had been drinking, 29% had a BAC of .100g/100ml or above, and 13% had a BAC of .200 or above. Three high risk groups were identified: teenaged sober pedestrians, elderly sober pedestrians, and young and middle-aged pedestrians, particularly males who had high BACs.


**Keywords**

PEDESTRIANS - BLOOD ALCOHOL CONCENTRATION - INJURY ACCIDENTS - HOSPITAL ADMISSIONS

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# EXECUTIVE SUMMARY

This study aimed to establish the association between the blood alcohol concentration (BAC) and the age and sex of adult pedestrians admitted to hospital.

BACs were obtained for 213 of the 232 pedestrians over 14 years of age who were admitted to the Royal Adelaide Hospital during a 22 month period (August 1985 to July 1987). Almost two-thirds of the pedestrians were male and, within every examined age group, male pedestrians exhibited a higher rate (per 10,000 population) of admission to hospital than did female pedestrians. Overall, 38% of the pedestrians with known BACs had been drinking, 29% had a BAC of .100g/100ml or above, and 13% had a BAC of .200 or above.

The results of this study identified three high risk groups: teenaged sober pedestrians, elderly sober pedestrians, and young and middle-aged pedestrians, particularly males who had high BACs ($\geq$.100). These findings suggest that media campaigns directed at lowering the road toll need to include reference to these groups.

Alcohol involvement was greater amongst pedestrians than amongst similar samples of injured drivers and motorcycle riders, although the differences between pedestrians and drivers were minimal at BACs below .100. This finding highlights the need for public recognition that alcohol is significantly associated with involvement in pedestrian accidents.

# ACKNOWLEDGEMENTS

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# LITERATURE REVIEW

The risks associated with drinking and driving are not only well documented in research (e.g. Borkenstein, Crowther, Shumate, Zeil & Zylman, 1964; McLean, Holubowycz & Sandow, 1980), but also publicly acknowledged. In contrast, however, alcohol involvement amongst pedestrians involved in accidents has attracted less attention. This study is therefore concentrated on alcohol involvement amongst adult pedestrians.

Older pedestrians are more likely to die from the injuries inflicted by a striking vehicle than are younger pedestrians (see, e.g. McLean, 1971). Therefore studies based on fatally injured pedestrians will be biased towards the elderly. Similarly, studies such as the one reported here, which is based on pedestrians admitted to hospital, will have some bias away from elderly pedestrians. However, as will be shown later, alcohol involvement tends to be concentrated primarily among the young and middle-aged. Therefore the present sample of hospital admissions probably provides a reasonable indication of the involvement of alcohol in serious pedestrian accidents.

## Studies of Injured Pedestrians

The available studies of the blood alcohol levels of injured pedestrians differ in their definitions of injuries and adult status and, in some instances, relatively large proportions of injured pedestrians were unmatched to BACs. For these reasons, the results of the studies are not readily summarized and therefore are presented individually in the following review.

Blomberg and Fell (1979) obtained BACs for 143 (79%) of 180 injured pedestrians aged 14 and above who were taken to hospital in New Orleans, and for 80 (93%) of 86 pedestrians who died within 24 hours of the accident. Of those injured who had a known BAC, 49% had a positive BAC, 36% a BAC of or above .100, and 23% a BAC of at least .200. As the BAC distribution of killed pedestrians did not differ significantly from that of the injured, they combined the fatal and non-fatal cases and noted that two-thirds of the victims with known BACs were males; one-third were at least 60 years of age. In the combined sample, an average of one in two males but only one in five females had a BAC of at least .100, and 31% and 12% respectively had a BAC of .200 or higher. The majority of those aged between 30 and 59 recorded BACs of at least .100.

Irwin, Patterson and Rutherford (1983) studied 50 consecutive pedestrians presenting at a Belfast hospital following a road traffic accident; 54% were males, and the age range was 13 to 72 with a median of 26. Forty-six per cent had a positive BAC, with a mean value of .170; 36% had a BAC greater than .080.

At least three studies have been conducted in Victoria. The first of these, by Ryan and Salter (1977), reported the BACs of 114 adult (greater than 14% years old) pedestrians who either attended the casualty department of, or were admitted to, the Alfred Hospital in Melbourne in 1975: 25% had a positive BAC and 13% were above .150.

Jordan and Young (1982) obtained BACs for 1690 (40%) of 4266 pedestrians aged 18 or above involved in accidents in Victoria from 1977 to 1979. Of the 1330 non-fatal cases treated in or admitted to hospital for whom BACs were available, 40% recorded a positive BAC and 21% had a BAC exceeding .150. (The authors did not report the percentage of hospital cases for whom BACs were available.) Although the authors also examined the age and sex characteristics of accident-involved pedestrians, those analyses were limited to victims involved in night-time accidents, and consequently are not reported here.A recent study in Melbourne, reported by Struik and Rogerson (1988), examined 232 pedestrians of all ages admitted to five hospitals throughout Melbourne and 58 pedestrians treated in the casualty departments of those hospitals but subsequently discharged. 60% and 71% of the admitted and casualty patients respectively were males. Of the admitted and casualty patients, 73% and 64% respectively were over 14 years of age, and 28% and 16% respectively were 60 or older. For those who were more than 14 years of age, BAC readings were obtained for 71% and 59% of the admitted and casualty patients respectively. Amongst the admitted patients, 36% of those with known BACs exceeded .010, 28% exceeded .100, and 11% exceeded .200. The corresponding figures for the casualty patients were 18%, 14% and 14%.

The one previous study of alcohol involvement amongst injured pedestrians in Adelaide was conducted as part of the Adelaide In-Depth Accident Study (McLean, Brewer & Sandow, 1979), where 43 pedestrians involved in 40 accidents to which an ambulance was called were examined. Three-quarters of the sample were at least 14 years of age and 21% were at least 60; 60% of the total sample was male. BACs were obtained for 27 (84%) of the 32 victims aged 14 or above: six had a positive BAC, five had a BAC of .100 or above, and two exceeded .200.

Several other studies have also looked at alcohol involvement amongst injured pedestrians but, for varying reasons, they are not directly relevant in the context of the current report. Warren, Simpson, Buhlman, Bourgeois and Chattaway (1982) excluded most of the seriously injured pedestrians; Galloway and Patel (1982) studied a sample of 14 pedestrians; Honkanen, Ertama, Kuosmanen, Linnoila and Visuri (1976) included only those pedestrians involved in accidents between 3pm and 11pm; and Atkins, Turner, Duthie and Wilde (1988) reported alcohol use by pedestrians (which was not defined) and not BACs.

Studies of Fatally Injured Pedestrians

As the current paper presents results derived from a sample of pedestrians admitted to hospital, the following review of the literature on age, sex and alcohol involvement in pedestrian fatalities is intended simply to provide some basis for comparison with the former group.

Fell and Hazzard (1985) reported that in the USA from 1980 to 1984 approximately 64% of all pedestrian fatalities were aged between 14 and 64 years inclusive, and 21% were aged 65 and older. The pedestrian fatality rates per 100,000 population during these years ranged from 2.7 to 3.2 and from 5.1 to 6.7 for the two age groups, respectively. Seventy per cent of all fatalities were male, but this percentage varied with age: males accounted for about 75% of the 14 to 64 year old fatally injured pedestrians and about 60% amongst the 65 and older group. BAC data was obtained from 15 US states which since 1980 have consistently tested and reported the BACs of over 80% of fatally injured adult (i.e. age 14 years or older) pedestrians. The authors found that about 40% of the adult pedestrians with known BACs were at or above .100, and about 25% had a BAC of at least .200. The average positive BAC was almost .200. Alcohol involvement was associated with age: between 1980 and 1984, the percentage of 14 to 24 year olds with a BAC at or above .100 ranged from 40% to 51%. These percentages were slightly less than those for pedestrians aged 25 to 64 (51% to 53%), and the corresponding percentages for pedestrians aged 65 or older were much lower (11% to 14%). Sex differences were also marked, with 48% of the male fatalities but only 23% of the female fatalities recording BACs at or above .100.

Clayton, Booth and McCarthy (1977) examined the records of all fatal pedestrian accidents involving adult (i.e. aged 15 years or over) pedestrians which occurred in the West Midlands area of the United Kingdom between 1969 and 1975. However, analyses were restricted to those who died within twelve hours of the accident. Of 394 cases, 54% were male, but as in Fell and Hazzard's (1985) study, age differences were apparent: 66% of the 15 to 64 year olds and 45% of those 65 and older were male. BACs of .100 and above were recorded by about 20% of the 344 for whom this information was reported, and 10% had BACs of .200 or more. Both these proportions are approximately half those reported by Fell and Hazzard (1985) in the USA. Again, alcohol involvement differed with sex: 29% of males but only 7% of females registered BACs of .100 or more.

Finally, Hossack and Brown (1974) noted that of 144 pedestrians of all ages killed in Victoria between mid 1970 and mid 1973, 89% were at least 20 years of age, and 18 % were over 70. BACs were obtained for 106 individuals: 33% of them exceeded .100, and 19%, .200.

## Studies of Alcohol and the Risk of Involvement in a Pedestrian Accident

Several studies have compared alcohol involvement between accident-involved and non-accident-involved pedestrians matched on certain characteristics such as site and time of accident, and age and sex of pedestrian. Some studies included only fatally injured pedestrians as cases (e.g. Clayton et al., 1977; Haddon, Valien, McCarroll & Umberger, 1961), whereas others also included injured pedestrians (e.g. Blomberg & Fell, 1979; Honkanen et al., 1976; Irwin et al., 1983; Struik & Rogerson, 1988).

Each of these studies has demonstrated that alcohol is over-represented in the accident-involved pedestrians and that the risk of accident involvement begins to increase at BACs of .080 to .120.

## METHOD

In South Australia, the law requires that a blood sample be taken for subsequent alcohol analysis from every person above the age of 14 years who presents at a hospital for treatment of injuries within eight hours of a road crash. From August 27th, 1985 to July 19th, 1987 the road user category was determined by one of the authors (OTH) for every individual injured in a road accident and subsequently admitted to the Royal Adelaide Hospital, which is the major trauma hospital for adults in South Australia.

The patient's case notes were reviewed and, if available, the reports of the ambulance officers; if any doubt remained (e.g. if the case notes were ambiguous or inconsistent), the patient was interviewed briefly to ascertain the correct category. Even after this approach, in some instances a road user category could not be assigned with confidence and therefore it was recorded as unknown in these cases.

It should be noted that although the majority of 15 and 16 year old trauma victims are transported to the Royal Adelaide Hospital or one of the other public hopitals servicing adults, a small minority are nevertheless taken to the Adelaide Children's Hospital. On the other hand, almost all of the 14 year old victims are seen at the Adelaide Children's Hospital.

During this period, 234 pedestrians were identified, who were hit by a motor vehicle on a public road. The sex, age and BAC was recorded in each case. Two pedestrians aged 14 were excluded from the sample because they were below the minimum age at which a blood alcohol sample is legally required. Sixteen of the remaining 232 pedestrians died while in hospital.

# RESULTS

Sex and Age

Of the 232 pedestrians, 147 or 63.4% were male. The mean age of the sample was 44.1 years (median = 39.5 years) and the ages ranged from 15 to 89 years. The mean age of the females was greater than that of the males (47.7 years and 42.0 years, respectively), although the difference was not statistically significant at a 5% level of significance (t = 1.87, 230df, p = .063). Table 1 presents the age breakdown by sex.

TABLE 1

AGE BY SEX OF PEDESTRIANS ADMITTED TO HOSPITAL

| Age (years) | | Sex | | Total | |
|---|---|---|---|---|---|
| | | Males | Females | % | No. |
| | 15-24 | 29.3% | 27.1% | 28.4 | 66 |
| | 25-44 | 28.6 | 18.8 | 25.0 | 58 |
| | 45-64 | 23.8 | 22.4 | 23.3 | 54 |
| | 65+ | 18.4 | 31.8 | 23.3 | 54 |
| Total: | % | 100 | 100 | 100 | - |
| | No. | 147 | 85 | - | 232 |

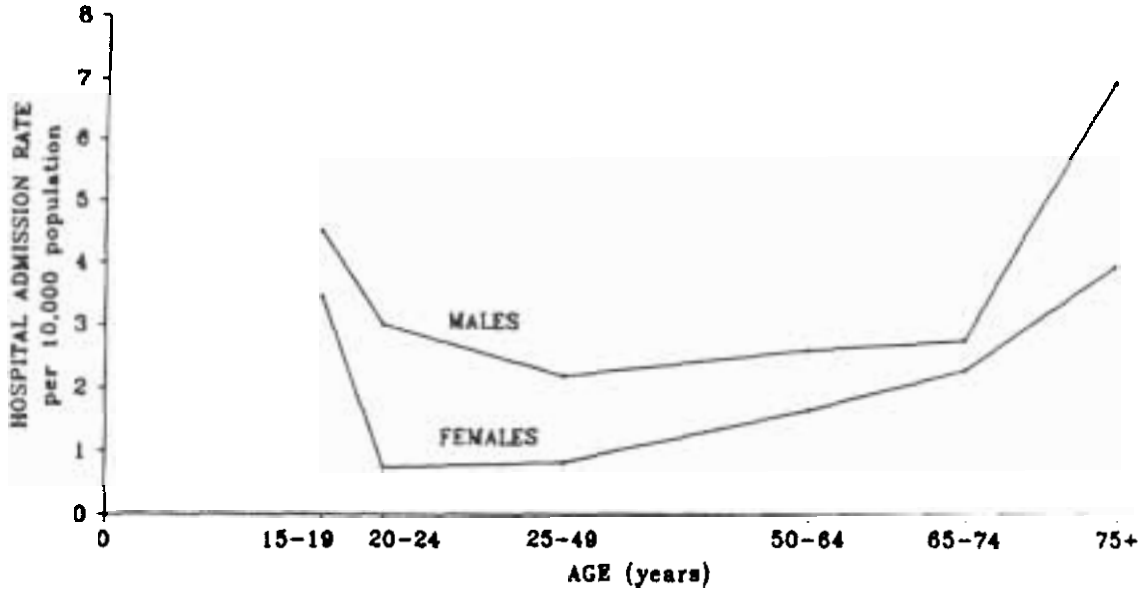
$x^2 = 6.3$, 3df, $p = .096$

No statistically significant differences were evident in these age distributions.

The sex distribution of the general population varies markedly with age: women outnumber men from about the age of 60. Hence, rates of admission to hospital were calculated, per 10,000 of the sex- and age- specific population of South Australia in 1986 (Figure 1). Male pedestrians within every age group examined exhibited a higher rate (per 10,000 population) of admission to hospital than did females, this difference being most pronounced in the age groups 20-49 and 75+. However, the age pattern within each sex was similar: the admission rate amongst teenagers was exceeded only by that amongst those aged 75 and over.

FIGURE 1

RATE OF HOSPITAL ADMISSIONS
BY AGE AND SEX OF PEDESTRIAN




## Blood Alcohol Concentration (BAC)

BACs were available for 213 or 91.8% of the 232 pedestrians: 38.0% of the known BAC cases had a positive BAC, the mean of which was .161 g/100ml (median = .164) and the range, .002 to .346. A statistically significant difference in the distribution of BACs was evident between males and females, as shown in Table 2.

TABLE 2.

BLOOD ALCOHOL CONCENTRATION (BAC) BY SEX OF

PEDESTRIANS ADMITTED TO HOSPITAL

| BAC (g/100ml) | Sex | | Total | |
|---|---|---|---|---|
| | Males | Females | % | No. |
| zero | 49.6%[1] | 83.3 | 62.0 | 132 |
| .001-.049 | 7.4 | 2.6 | 5.6 | 12 |
| .050-.099 | 4.4 | 2.6 | 3.8 | 8 |
| .100-.199 | 19.3 | 9.0 | 15.5 | 33 |
| .200+ | 19.3 | 2.6 | 13.1 | 28 |
| Total (BAC known) % | 100 | 100 | 100 | |
| No. | 135 | 78 | - | 213 |
| BAC unknown | 12 | 7 | - | 19 |

$x^2 = 25.4$, 4df, $p < .001$

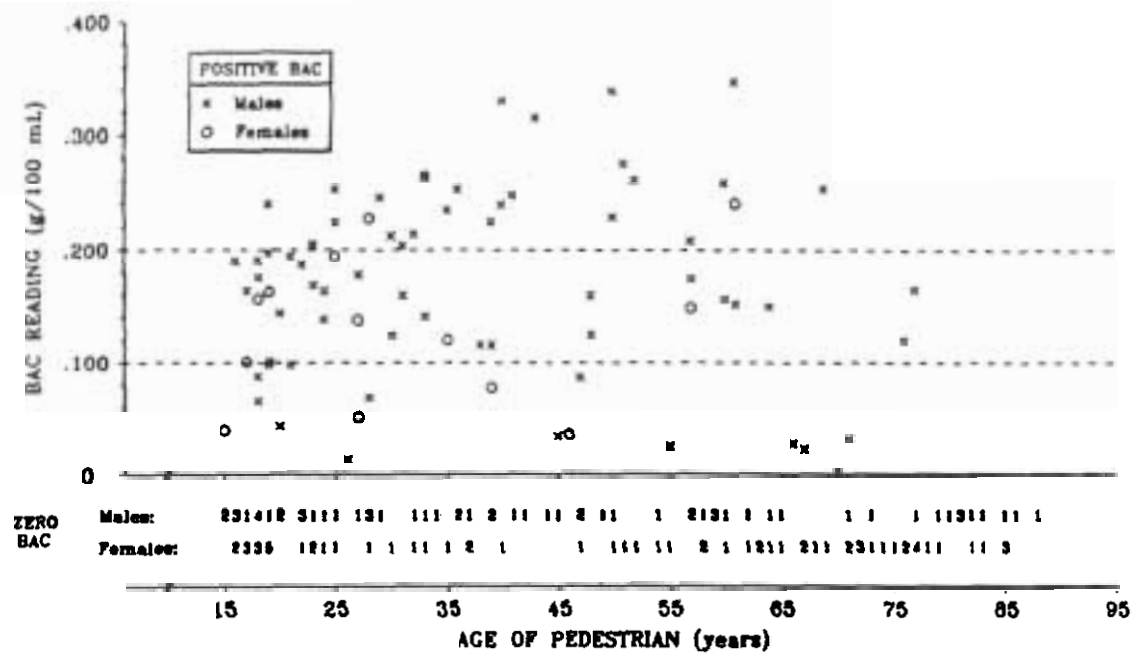
1- % of total BAC known cases

Males were much more likely than females to have a positive BAC (50.4% and 16.7%, respectively: $x^2 = 22.4$, 1df, $p < .001$), and the mean positive BAC was greater for males than for females (.167 and .130, respectively, although this difference was not statistically significant ($t = 1.46$, 79df, $p = .149$).

Individual BACs are shown together with the age and sex of each pedestrian in Figure 2.

FIGURE 2

BLOOD ALCOHOL CONCENTRATION, AGE AND SEX OF PEDESTRIANS ADMITTED TO HOSPITAL




The number of males and females with a zero BAC at each year of age are listed directly below the scattergram. Very high BACs (.200 and above) were rarely evident amongst those either below 25 or above 64 years of age (5.1% and 2.0%, respectively). In contrast, 29.1% of those aged 25-44 and 16.7% of those aged 45-64 had a BAC of at least .200. Similarly, eleven of the twelve individuals with BACs above .250 were in the 25 to 64 year age group.

Table 3 shows the proportion of each age group, within each sex, who had a BAC at or above .100, a blood alcohol range which could reasonably be assumed to be associated with a meaningful degree of impairment in terms of safe walking. Statistically significant differences in the proportions of pedestrians with a BAC at or above .100 were evident in various age groups in the total sample: those aged between 25 and 44 were most likely to be impaired, whereas those aged 65 and over were least likely to be so. A similar pattern was evident amongst both males and females, although with no statistically significant differences in the latter group.

Figure 3 shows the rate of hospital admissions by age and sex for those pedestrians with known BACs; Figure 4 depicts this rate for those who were known to have a BAC less than .100 (including zero). A comparison of the two graphs shows that the sex differences in hospital admission rates for those aged between 20 and 64 are due primarily to those males who had high ($\geq$ .100) BAC levels.

TABLE 3.

BLOOD ALCOHOL CONCENTRATION (BAC) BY AGE AND SEX OF PEDESTRIANS ADMITTED TO HOSPITAL

| BAC (g/100ml) | Age (years) | | | | Total | | $x^2$ |
|---|---|---|---|---|---|---|---|
| | 15-24 | 25-44 | 45-64 | 65 + | % | No. | |
| Males | | | | | | | |
| > .100 | 39.5%[1] | 52.5 | 40.6 | 12.0 | 38.5 | 52 | 10.8, 3df |
| | | | | | | | p = .013 |
| Total known: % | 100 | 100 | 100 | 100 | 100 | | |
| No. | 38 | 40 | 32 | 25 | - | 135 | |
| BAC unknown | 5 | 2 | 3 | 2 | - | 12 | |
| Females | | | | | | | |
| > .100 | 14.3%[1] | 26.7 | 12.5 | 0 | 11.5 | 9 | 6.9, 3df |
| | | | | | | | p = .074 |
| Total known: % | 100 | 100 | 100 | 100 | 100 | | |
| No. | 21 | 15 | 16 | 26 | - | 78 | |
| BAC unknown | 2 | 1 | 3 | 1 | - | 7 | |
| All | | | | | | | |
| > .100 | 30.5%[1] | 45.5 | 31.2 | 5.9 | 28.6 | 61 | 20.8, 3df |
| | | | | | | | p < .001 |
| Total known: % | 100 | 100 | 100 | 100 | 100 | | |
| No. | 59 | 55 | 48 | 51 | - | 213 | |
| BAC unknown | 7 | 3 | 6 | 3 | - | 19 | |

1 - % of total BAC known cases

FIGURE 3

RATE OF HOSPITAL ADMISSIONS BY AGE
AND SEX OF PEDESTRIANS WITH KNOWN BACs

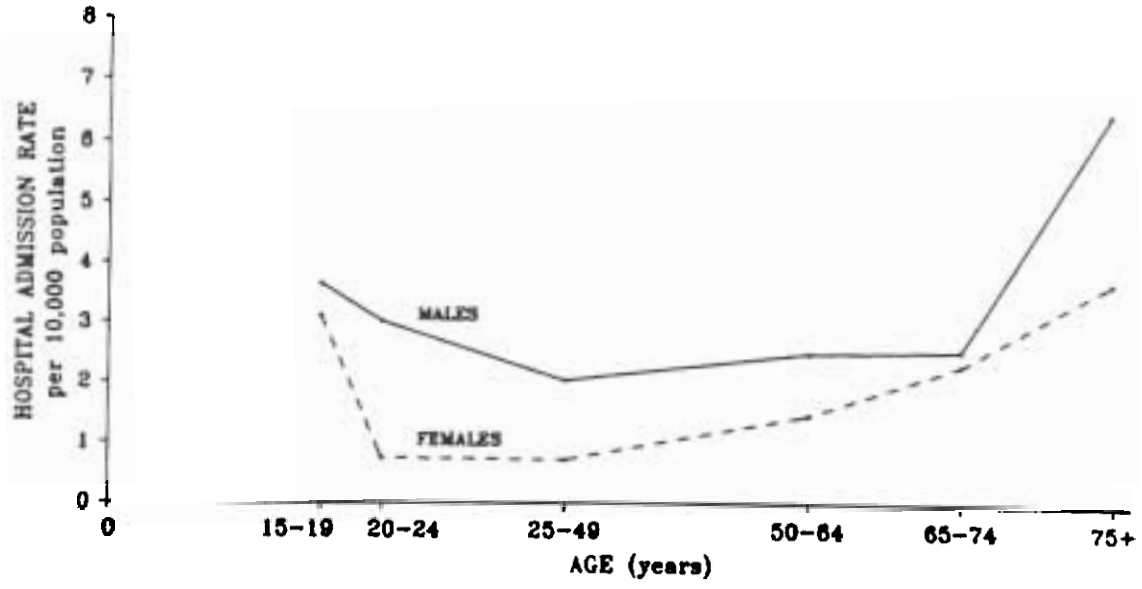
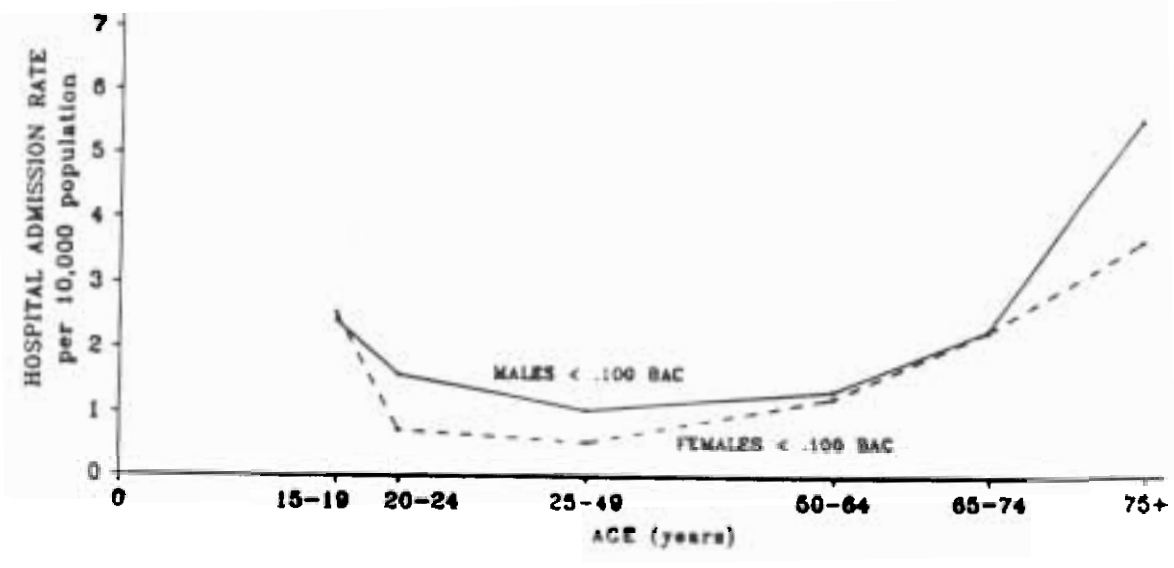



FIGURE 4

RATE OF HOSPITAL ADMISSIONS BY AGE AND SEX
OF PEDESTRIANS WITH BACs LESS THAN .100 g/100mL

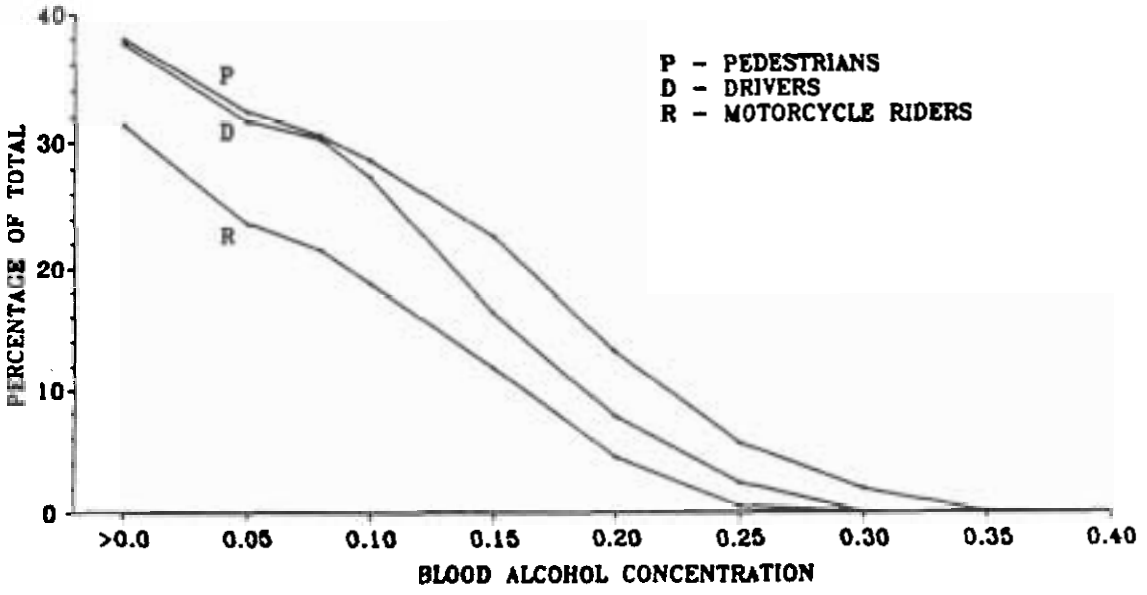


Blood Alcohol Concentration and Type of Road User

During the period of this study 620 injured drivers and 406 injured motorcycle riders admitted to the Royal Adelaide Hospital were also identified and their BACs obtained. Figure 5 depicts the percentages of each group with BACs at or above the BAC specified on the x-axis at each point. A larger proportion of pedestrians than drivers exceeded each specified BAC, with the differences being minimal below .100. Only pedestrians were represented above .300. The proportion of drivers exceeded that of riders at each BAC level.

FIGURE 5

BLOOD ALCOHOL CONCENTRATION BY TYPE OF ROAD USER
ROYAL ADELAIDE HOSPITAL ADMISSIONS
SEPT. 1985 - JULY 1987



# DISCUSSION

The current study of injured adult pedestrians is the largest in which BACs have been obtained for a high proportion (92%) of the pedestrians, together with their age and sex. One other study of injured pedestrians, by Jordan and Young (1982), was based on a larger sample than that examined in the current study, but the match rate was less than 40%.

This study of adult (age 15 or above) pedestrians admitted to the major trauma hospital in South Australia has shown that almost two-thirds of the injured pedestrians were males, and almost a quarter were aged 65 or above. These proportions lie within the ranges indicated by earlier studies of injured pedestrians, as described in the Introduction.

The BAC distribution observed in the current study is similar to those reported by two other Australian studies of injured pedestrians (Jordan & Young, 1982; Struik & Rogerson, 1988), although an earlier study by Ryan and Salter (1977) indicated less alcohol involvement. In contrast, however, the two largest comparable overseas studies, conducted in New Orleans (Blomberg & Fell, 1979) and Belfast (Irwin et al, 1983), have reported higher proportions of pedestrians who had been drinking, and a higher proportion with BACs above .100. The sample sizes in the other studies of injured adult pedestrians (e.g. Galloway & Patel, 1982; Honkanen et al, 1976; McLean et al, 1979; Warren et al, 1982) are small (less than 35).

Sheehy (1982) had previously noted that sex differences in prior alcohol consumption have rarely been considered when explaining the overall sex difference in adult pedestrian accident rates. Consequently, this study examined the hospital admission rates (per 10,000 population) for both male and female pedestrians, whilst simultaneously taking into account the contribution of probable impairment by alcohol. As noted earlier, although male pedestrians within every age group examined exhibited a higher rate of admission to hospital than did females, the sex differences for those aged between 20 and 64 were accounted for primarily by those males with high ($\geq$ .100) BACs.

Previous road accident countermeasures directed at alcohol have focussed almost exclusively on drivers and riders. However, this study showed that injured pedestrians admitted to hospital were more likely to have been drinking than a similar sample of injured motorcycle riders, and much more likely to have had a BAC above .150 than either injured drivers or riders. If alcohol involvement amongst drivers and riders involved in pedestrian accidents is also considered, the proportion of pedestrian accidents in which alcohol is a factor will be higher than that reported in this and other studies of injured pedestrians.

Together with the findings of case-control studies which have demonstrated a strong positive association between a pedestrian's BAC and risk of accident involvement, above a level of about .08g/100ml, this finding points to the urgent

need for public recognition of the risks associated with walking on or across a public road when intoxicated.

Drivers and riders are subject to a legal blood alcohol limit when on the roads, but pedestrians are not. Although public drunkenness is no longer an offence in South Australia, under the Public Intoxication Act police have the right to detain, without arrest, intoxicated pedestrians for reasons of their own safety. Therefore police officers should be encouraged to recognize not only their rights in detaining pedestrians under this Act, but also the potential they have to limit the exposure of such pedestrians to traffic, and consequently lower the likelihood of their involvement in alcohol-related pedestrian accidents.

The current study did not examine the association between time of day and alcohol involvement. However, as would be expected from other studies of drinking behaviour, pedestrian accidents involving alcohol are known to be more likely to occur at night-time (e.g. Jordan & Young, 1982). Measures which make it easier for drivers to see a pedestrian at night will therefore be of particular benefit to those pedestrians who are intoxicated and who, albeit unwillingly, rely on the driver to take avoiding action.

## RECOMMENDATIONS

- That the public be made aware of the risk associated with walking on or across a public road when intoxicated.

- That active discouragement of drinking and driving should avoid encouraging intoxicated persons to walk.

- That police officers be encouraged to take whatever means are legally available to them to remove intoxicated pedestrians from the road system, so as to reduce the risk of the pedestrian being struck by a motor vehicle.

- That the adoption of measures which increase the night-time conspicuity of pedestrians be actively encouraged.

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