

ALCOHOL AS A RISK FACTOR FOR TRAIN COMMUTING FATALITIES

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ABSTRACT

Railway fatalities are an important subset of transport-related fatalities, which account for about 60% of the fatal unintentional injuries occurring in Cape Town. The Medical Research Council reviewed three and a half years of rail injury data and found that alcohol was one of the main risk factors. Furthermore, 33% of South Africa's national rail fatalities tested positive for alcohol in 1999. Despite the links between alcohol and all types of transport-related injury, prevention efforts have targeted motor vehicle (MV) drivers exclusively.

This study aimed to clarify the relationship between alcohol and the risk of all types of transport-related injury (particularly rail injury). Post mortem reports for transport fatalities were collected retrospectively from the two Cape Town mortuaries at Salt River and Tygerberg for the period 1 January 1994 to 31 December 1996. A case control study design was used with the cases comprising rail passenger and rail pedestrian fatalities, while motor vehicle drivers and passengers were the controls for the passenger group and motor vehicle pedestrians were the controls for rail pedestrians. Blood alcohol concentration was the dependent variable, the independent variables were age, sex, race, date of death, day of week, time of injury and mechanism of death and the odds ratio was used as the measure of relative risk. The results of the study are summarised in the table below.

	Rail passenger vs MV passenger	Rail passenger vs MV driver	Rail pedestrian vs MV pedestrian
Odds ratio	5.23	2.3	1.44
95% confidence interval	1.99 – 13.7	0.9 – 5.77	0.89 – 2.31

The study showed that alcohol consumption is an important risk-factor for rail fatalities. The odds ratios imply that rail passengers are 5.23 or 2.3 times as likely to be intoxicated than motor vehicle passengers or motor vehicle drivers respectively, while rail pedestrians are 1.44 times more likely to be intoxicated than motor vehicle pedestrian fatalities. Alcohol

plays as important a role, if not more so, for drunken rail passengers and pedestrians as it does for drunken drivers and road pedestrians. The role of alcohol in rail pedestrian fatalities is significant when compared to motor-vehicle pedestrians as a control group. The study has also demonstrated that data provided by the National Injury Mortality Surveillance System can form the basis for analytic studies on the risk-factors of injury.

The results complement a growing body of research that documents the adverse health effects of excessive alcohol consumption and provide more evidence for public health campaigners to tackle endemic alcohol abuse in South Africa.

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DECLARATION

I, Richard Matzopoulos, hereby declare that the work on this dissertation is based on my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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ABBREVIATIONS

AGECAT – age of deceased categorical variable

BAC – blood alcohol concentration

CERSA – Centre for Epidemiological Research in South Africa

CSIR – Council for Scientific and Industrial Research

DOW – Day of week variable

DUI – driving under the influence

MRC - Medical Research Council

MV – motor vehicle

NIMSS – national injury mortality surveillance system

NTRP – National Trauma Research Programme

OR – odds ratio

SAPS – South African Police Services

TIMECAT – Time of death categorical variable

UCT – University of Cape Town

UNISA – University of South Africa

YOD – Year of death categorical variable

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1. INTRODUCTION

1.1. Background

1.1.1. Railway injury research in South Africa

Between 1980 and 1998 only six articles appeared in the medical literature relating directly to railway injury in South Africa (Singer & Anderson, 1988; Fosseus, 1986; Addison, 1981; Lerer & Matzopoulos, 1996; 1997; Matzopoulos & Lerer, 1998). An unpublished analysis of local mortality data revealed 116 railway fatalities in the Cape Peninsula in 1984, of which most of the victims were males (Fosseus, 1991). A study of orthopaedic morbidity at Groote Schuur Hospital revealed that more than half of all train injuries (56%) affect those under the age of thirty, with a high cost of disability and rehabilitation (Singer & Anderson, 1988).

The National Trauma Research Programme of the Medical Research Council (MRC) identified an unusually large number of railway injuries in the 1990 Cape Metropolitan Study and recognised railway injuries as a priority area for trauma research (National Trauma Research Programme, 1990). The data also highlighted the severity of railway accidents, with more than 30 percent of incidents resulting in death (M. Peden, NTRP - personal communication). As a result of this anecdotal evidence, a pilot study was initiated in 1993 by the Departments of Community Health and Forensic Medicine, University of Cape Town, and the Community Health Research Group of the MRC, in co-operation with Cape Metro Rail Services¹, the Western Cape rail utility. During 1994, a contractual agreement was concluded between Cape Metro Rail Services and the MRC to undertake a formal three-year study into injury on the Cape Town metropolitan rail system. The initial report (Lerer & Matzopoulos, 1995) validated and substantially expanded on the results of the pilot study. Three and a half years of data collected by Metrorail were reviewed and the extent and nature of railway injuries was described. Among the interventions for rail-related injury, it

¹ Cape Metro Rail Services were renamed Cape Metrorail in 1996.

was recommended that no drinking of alcohol be allowed on station premises, and that alcohol and tobacco advertising be removed from stations to highlight the link of rail travel with health promotion and healthy environments.

Alcohol was identified as one of the main risk factors for railway injuries. Forty-four percent of all fatalities tested were blood alcohol concentration (BAC) positive. Furthermore, this report contained a framework for an injury surveillance system and recommendations for the implementation of injury control strategies.

1.1.2. Non-natural mortality surveillance in Cape Town

In South Africa, transportation accidents contribute substantially to the burden of disease, especially among the poor and disadvantaged (Bradshaw, Dorrington, Sitas, 1992). In terms of the Inquests Act of 1959, as amended (Republic of South Africa, 1959), the current medico-legal process requires that a district surgeon, forensic pathologist or medical practitioner examine all non-natural deaths. This is not the case in many industrialised countries, where autopsies are not always required by law for non-natural deaths. It has been suggested that the benefits of post-mortem examination findings for public health surveillance of injuries and the improvement of trauma care are substantial (Pollock, O'Neil, Parrish, et al 1993). Injury surveillance systems can provide a quantitative estimate of morbidity and mortality, detect clusters, stimulate epidemiological research, and help to evaluate the effectiveness of interventions (Graitcer, 1992).

In Cape Town in 1993 descriptive mortality statistics, based on medico-legal data, were compiled from the state mortuaries at Tygerberg and Salt River (Matzopoulos 1994). Technical reports on non-natural mortality were published by the MRC in the following two years (Lerer et al., 1995; Cape Town Non-natural Mortality Study Group 1996), and data collection was funded by the MRC and the Department of Forensic Medicine, University of Cape Town, between 1996 and 1998. This process provided the foundation for a national

injury mortality surveillance system (NIMSS), which is currently being developed in South Africa and funded by the Department of Arts, Culture, Science and Technology, on behalf of the National Crime Prevention Strategy. The NIMSS will eventually register and record 21 information items for all deaths caused by violence and injury that occur annually in South Africa. The NIMSS data collection form is attached in Appendix 1.

1.1.3. Problem statement

Modern injury epidemiology purports that unintentional injuries (or accidents) are not "acts of God" and are preventable (Mark Rosenberg, closing address, 4th World Conference on Injury; Berger and Mohan, 1996). The public health approach to injury provides a scientific framework for addressing the prevention and control of injury, through the use of education, regulation and re-engineering of the environment.

Transport-related fatalities accounted for more than 60% of the fatal unintentional injuries occurring in the Cape Town Metropole in 1994 and 1995, and positive BACs were recorded in more than half of these fatalities (Lerer et al., 1995, Cape Town Non-natural Mortality Study Group, 1996). Railway fatalities are an important subset of transport-related fatalities, and although they only accounted for between 10 and 20% of all transport fatalities, the number of deaths per commuter kilometre travelled was marginally lower than the provincial road fatality rate (Matzopoulos & Lerer, 1998). This is an untenable situation, as rail travel is regarded in industrialised countries as one of the safest means of public transport (Ward & Wilde, 1995; British Medical Association 1987).

Alcohol is a risk-factor for the victims of several categories of injury, particularly violence and transport-related injuries (Lerer et al., 1995). Despite the link between alcohol and the various forms of transport-related fatalities, prevention efforts have targeted motor vehicle (MV) drivers exclusively, both through media campaigns, which urge drivers not to "drink

and drive" and regulation, which penalises drivers whose BAC levels exceed the legal limit of 0.08g/100ml (recently lowered to 0.05 g/100ml).

Nearly five years after the MRC's three-year study on railway injury, 33% of South Africa's rail fatalities tested positive for alcohol (Violence and Injury Surveillance Consortium, 2000). Alcohol is still advertised at railway stations and drunk people continue to access the system in the absence of effective barriers next to railway lines particularly in peri-urban communities. Furthermore alcohol is still sold at Cape Town Station and on the Simonstown Line's "buffet-coach". Epidemiological research will add to the body of evidence that alcohol is a major risk factor for railway-related injury, and will speed-up the enforcement of regulatory measures to address the problem.

1.2. Aims

This study aimed to show more clearly the relationship between alcohol consumption and the risk of all transport-related injury (particularly railway injury), in the hope that the results would motivate public health and transport authorities to investigate avenues for prevention. Strict selection criteria were used to improve the epidemiological basis for making comparisons between fatalities from different modes of transport. The study also tested the suitability of the NIMSS, which is being expanded nationally to include mortuaries in each province, as an analytic tool that could prove or disprove the effectiveness of injury prevention programmes.

1.3. Objectives

The specific objectives of the study were:

1. to measure the number of transport-related fatalities that occur in the Cape Town Metropole in a three-year period among five mutually exclusive groups during day-time commuting hours:
 - rail passenger fatalities,
 - rail pedestrian fatalities,
 - motor vehicle passenger (MV passenger) fatalities,
 - motor vehicle driver (MV driver) fatalities and
 - motor vehicle pedestrian (MV pedestrian) fatalities.
2. to determine the mean blood alcohol concentration among these five groups.
3. to determine the mean blood alcohol concentration among those fatalities who were alcohol positive.
4. to investigate the role of explanatory variables (age, sex and race²) and to see whether they are confounding or effect modifying variables for the relationship between blood alcohol concentration and the type of transport-related fatality.
5. to highlight the role of alcohol in transport-related fatalities

1.4. Overview of the Dissertation

This dissertation includes a literature review of articles from the MEDLINE electronic database, unpublished data and grey literature on railway injury and alcohol and transport related injuries. The Method section describes the design of the study, data sources consulted, data collection, the population and sampling procedure with reference to the

exclusion criteria used in the study, a description of the data (including each variable), data cleaning, analysis, ethics and the quality of the data obtained. The Results section summarises the selection of cases, the relationship between BAC and each explanatory variable, and case-control analysis for rail passenger versus MV passenger fatalities, rail passenger versus MV driver fatalities and rail pedestrian versus MV pedestrian fatalities.

The Discussion section provides an interpretation of the results, describes some of the limitations of the study and summarises the role of alcohol in transport-related fatalities. In the Conclusion the implications of the study for transport utilities, policy makers and researchers are discussed.

2. LITERATURE REVIEW

Railway injury is an important subset of transport injury in Cape Town, accounting for one eighth of transport fatalities (Lerer et al., 1995). Unlike industrialised nations where railway fatalities and injury are confined mainly to suicides (Schmidtke, 1994; Symonds 1994), rail disasters (Cugnoni, Fincham, Skinner, 1994) and train/motor vehicle accidents at level crossings (Ward & Wilde 1995), factors contributing to rail fatalities in the Cape Town Metropole are compounded by incidents of criminal and political violence, and gross risk-taking by commuters. The large number of informal settlements that have developed next to the railway lines in peri-urban areas also substantially increases the number of pedestrians at risk.

The severity of railway trauma (Ward & Wilde, 1995; Singer & Anderson, 1988) places a considerable financial and emotional burden on survivors, their next of kin and the state. Many survivors require vigorous orthopaedic intervention and many serious crush and avulsion injuries require amputation (Singer & Thordarson, 1994; Moore, Wilson, Hartman,

² In this case, race is used as a proxy for socio-economic status in the absence of a more suitable variable.

1991). In a local study more than half of all railway injuries affected those under the age of thirty, with a high cost of disability and rehabilitation (Singer & Anderson 1988).

The Medical Research Council conducted a study of the local rail utility, Cape Metrorail, in 1995. A detailed technical report described the occurrence of railway-related injury and suggested possible areas for intervention (Lerer & Matzopoulos, 1995). These included the improvement of the injury surveillance system, as there was a high level of underreporting, and the development of a framework to apply public health solutions in the form of re-engineering, education and enforcement. Possible risk factors that were identified by the study included overcrowding, criminal violence, risk-taking behaviour by commuters and the excessive use of alcohol (Lerer & Matzopoulos, 1995; 1996).

Some of the interventions suggested in the technical report were implemented by Metrorail of their own accord, particularly the re-engineering of commuter carriages and increasing security personnel at stations and on trains. Attempts were also made to educate commuters on safe commuting practices. However, the reality of the rail utility affecting behavioural changes among its commuters is questionable, due to its historical legacy as the apartheid transport provider. Public transport was a battlefield during the mid-1980s, as political groups sought to cause economic and political disruption. Trains were stoned and burned to ensure that calls for stay-aways and strikes were heeded, and disputes between rival taxi associations erupted in violence and intimidation (Bekker & Louw 1992; Banks 1991).

Metrorail's limited success in addressing the injury problem is borne out by recent statistics and newspaper reports, which show that the injury situation does not appear to have improved noticeably³ (Cape Argus 1999a, 1999b, 1999c; Saturday Argus 1999). The role of

³ The MRC extended their research contract with Metrorail until 1998 and continued to monitor rail-related injuries.

alcohol as a risk factor for rail-related injury has largely been ignored, despite the technical report showing that more than 40% of fatalities (including violence) had positive BACs.

Alcohol is readily available in South Africa, although per capita alcohol consumption figures are no higher than many other countries. In a comparative study of adult per capita consumption in 31 countries, Hurst, Gregory & Gussman (1997) placed South Africa in 21st position. Their figures, however, under-estimate the amount of sorghum beer consumed. It is therefore much more likely that South Africa would rank between 10th and 15th place on the list (C. Parry, MRC – personal communication). Hurst et al (1997) also compared over 23 countries (including Canada, France, Germany, Japan, Spain, the UK and USA) in terms of their average annual growth rate in per capita consumption between 1985 and 1995. South Africa ranked highest with a growth rate of 2%. There is a tendency to binge drink, leading to infrequent, but particularly high levels of drunkenness in individuals, and the alcohol consumption rates also show considerable interprovincial variation (Directorate of Traffic Safety 1992).

Although the true prevalence of alcohol-related traffic injuries in developing countries remains unknown, studies have shown that alcohol increases the risk for an individual to die an unnatural death (Hain, Ryan, Spitz, 1989; Raffle 1989; Knight 1990) and that drinking increases the risk of being involved in a road traffic accident (Galloway & Patel 1982; Irwin, Patterson, Rutherford, 1983). Furthermore, alcohol is believed to compromise survival after severe trauma (South Australian Health Commission 1991). It is not inconceivable that the same should be true for railway accidents. Several studies allude to the relationship between alcohol and railway fatalities (Cina, Koelpin, Nichols et al., 1994; Fosseus 1986), but no studies listed on MEDLINE or POPLINE address the problem of alcohol intoxication among railway pedestrians and passengers specifically.

Blood alcohol concentration is a measurement of the percentage of alcohol in the blood. The percentage of alcohol in the blood depends on 1) the quantity of alcohol consumed, 2) body chemistry, particularly weight, and 3) the time taken to consume a quantity of alcohol or the presence of food in the stomach. The stomach enzyme, ADH, breaks down 30% of alcohol in men. Women absorb more alcohol than men because they have less of this enzyme in their stomachs. Women weigh less than men and have less water in their bodies, so drinking the same amount of alcohol results in a higher BAC. Alcohol in the bloodstream circulates to the brain and affects the way a person behaves, and the dose-response relationship has been reported as follows:

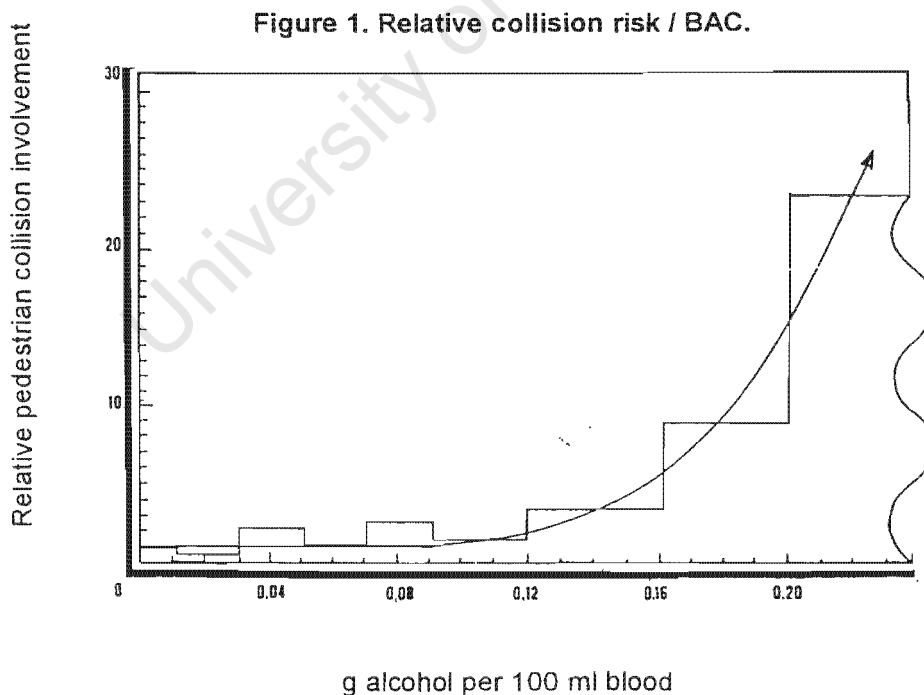
- Up to 0.04 g/100 ml results in feelings of contentment, happiness and relaxation
- 0.06 g/100 ml results in impaired judgement, some loss of physical co-ordination, and an impaired ability to make rational decisions about capabilities
- 0.08 g/100 ml results in impaired muscle co-ordination and driving ability
- 0.10 g/100 ml results in deterioration of judgement, motor control and reaction time
- 0.30 g/100 ml may result in loss of consciousness and death.

(Alberta Alcohol and Drug Abuse Commission 1996)

Transport authorities in South Africa have attempted to reduce alcohol consumption among motor vehicle drivers and among road pedestrians with varying degrees of success. The alcohol limit for passenger motor vehicle drivers in South Africa has recently been changed from 0.08 g/100ml to 0.05 g/100ml, while for commercial drivers it has been reduced to 0.02 g/100ml (<http://www.transport.gov.za>). Legal limits in European countries and states in the USA usually vary from 0.10g/100ml to 0.05g/100ml, with the lowest limit being 0.02g/100ml (Hingson, 1993). It has been shown that reducing the legal blood alcohol limits from

0.10g/100ml to 0.08 g/100ml is associated with a significant decline in the proportion of crashes involving fatally injured drivers whose blood alcohol levels are 0.08g/100ml or higher (Hingson, Heeren, Winter, 1996).

The Grand Rapids Study by Borkenstein, Crowther, Shumate, et al (1964) established a well known risk function depicting the alcohol-related accident risk by analysing the prevalence of driving under the influence of alcohol (DUI) and the frequency with which DUI drivers are involved in accidents. At a level of 0.06g/100ml drivers are twice as likely to be responsible for causing a collision, at 0.10g/100ml seven times as likely and at 0.15g/100ml 25 times as likely, when compared with drivers having less than 0.01g/100ml in their blood (Borkenstein et al, 1964). For pedestrians the curve shifts somewhat to the right so that a pedestrian has a 4 to 5 fold increased risk of being involved in a collision at 0.16 g/100ml and then this rises exponentially. Figure 1 depicts the risk function from the Grand Rapids study for pedestrians, which shows that the collision risk for drivers increases exponentially with rising BAC.



Strategies to prevent DUI have relied mainly on educational campaigns and enforcing a maximum legal BAC limit for motor vehicle drivers. Hard hitting advertising campaigns and well-publicised arrest figures have been posited as one of the deterrents for DUI, along with the high visibility of roadside breathalyser tests (Dean, 1995). Successful regulation campaigns have introduced lower legal limits for BAC and progressive penalties for those above the legal limit (Marks, 1997), including heavier fines and revoking driving licenses (Dean, 1995). In the United States BAC regulation has successfully targeted high risk groups, such as minors (Hingson, 1993).

Nearly 40% of the people who die on South Africa's roads annually are pedestrians (Violence and Injury Surveillance Consortium, 2000). The association between alcohol and road pedestrian injuries is well-documented in South Africa (Peden, 1997; Van der Spuy, 1996). The risk factors for alcohol-impaired pedestrians are not yet well defined (Transportation Research Board; 1990, 1993), but it is believed that the problem is compounded by drinking while walking, reckless behaviour and not being visible to drivers (Directorate of Traffic Safety, 1992; 1994).

Positive BACs were found in 40 to 50% of the fatally injured road pedestrians in the United States between 1982 and 1992 (Centre for Disease Control, 1993). A number of independent studies have shown that pedestrians killed in road traffic accidents are more likely than controls to have alcohol in their blood (Haddon, Valien, McCarrol et al., 1961; Clayton, Booth, McCarthy, 1977; Jehle & Cottington, 1988; Irwin et al, 1983; Miles-Doan, 1996). Alcohol involvement has been shown to be more prevalent among pedestrians than other road users (Holubowycz, 1995; Peden, 1997).

Public health strategies to address the epidemic of alcohol-related road pedestrian fatalities in the United States have included increasing the priority of preventing pedestrian injuries for public health agencies, traffic safety offices and law enforcement officers, educational

campaigns and design/engineering interventions (Centre for Disease Control, 1993). The reduction of alcohol-related injuries among pedestrian road users has been fraught with problems, and this might also be the case among rail pedestrians. In Scotland, legislation has not reduced pedestrian injuries and death, but it has been partially successful in reducing alcohol-related deaths in vehicle users (Bradbury, 1991). Three states in Australia have legislation allowing the mandatory taking of blood samples for blood alcohol analysis from injured pedestrians who present to hospitals (Holubowycz, 1995). In the United States educational campaigns include the provision of public education in high risk locations such as city-centre night-spots and increasing training in responsible alcohol service for establishments that serve alcohol. Design interventions have concentrated on separating pedestrians from traffic lanes using guard rails or overpasses (Centre for Disease Control, 1993).

Prevention of pedestrian alcohol consumption is made difficult by the high prevalence of intoxication among pedestrians and the acceptance of drinking as normative social behaviour in South Africa. A study conducted among 500 shebeen visitors in the Western Cape, Gauteng and the Eastern Cape revealed a tendency to drink twice a week (50% of pedestrians) and to walk home after drinking. Respondents were not keen to change their drinking or behaviour patterns (Directorate of Traffic Safety, 1993).

No figures are available for national railway fatalities, but it is estimated that nearly 70% of the railway fatalities in the Cape Town Metropole are pedestrians (Lerer & Matzopoulos, 1995). It has also been shown that pedestrian fatalities among rail fatalities, as well as road-related cases, are more likely to have elevated blood alcohol levels (Holubowycz, 1995). A study which sampled a selection of post-mortems, showed that 41% of road traffic fatalities (including pedestrian deaths) and 50% of rail fatalities had positive BAC. The mean blood alcohol level among those who tested positive was considerably higher among the railway

deaths (0.26g/100ml) than among the road deaths (0.15g/100m) (South Australian Health Commission, 1991).

3. METHODS

3.1. Study Design

A case-control study design was used with two separate comparisons between unintentional railway-related and motor vehicle fatalities. The two groups of cases comprised railway pedestrian and railway passenger fatalities, while MV pedestrian and MV passenger fatalities were the respective control groups. MV driver fatalities were used as a benchmark for the comparison of the passenger fatality groups (railway passenger and MV passenger).

The study comprised a retrospective analysis of secondary data sources from 1 January 1994 to 31 December 1996. Transport-related fatalities presenting to Cape Town's two forensic pathology laboratories, i.e. Salt River and Tygerberg, were selected for the study. The fatalities were divided into four mutually exclusive groups:

- MV passenger fatalities
- MV pedestrian fatalities
- MV driver fatalities
- Railway fatalities

Railway fatalities were collected and sorted into four causal categories: intentional (violence), self-inflicted intentional (suicides), unintentional and an undetermined category. In this study only unintentional fatalities were included, and these were allocated to two groups comprising:

- unintentional *railway passenger* fatalities and,

- unintentional *railway pedestrian* fatalities.

3.2. Data Sources

The two Cape Town mortuaries were assumed to provide full coverage of mortality due to the strict medico-legal code of South African law. It is a statutory requirement that all non-natural deaths be examined by a district surgeon, forensic pathologist or medical practitioner, under the Inquests Act of 1959 (Republic of South Africa, 1959).

Some of the railway pedestrian, passenger and suicide deaths were recorded in mortuary records simply as 'railway fatalities', so these deaths were matched with injury report forms completed by railway personnel in compliance with the Machinery and Occupational Safety Act of 1983⁴ (MOSA) and the Occupational Health and Safety Act of 1995 (OHSA) to increase the accuracy of the mechanism of death variable (Republic of South Africa, 1983; 1995). MOSA/OHSA requires that any incident resulting in injury from the use of machinery be reported to the occupational safety inspectorate of the Department of Manpower/Labour.

3.3. Data Collection

Information was extracted from the computerised database of the death registers from Salt River and Tygerberg medico-legal laboratories, for the period 1994 to 1996. Data had been captured using the EPI-INFO epidemiological package (Dean, Dean, Burton, et al, 1990) by mortuary attendants. The database is the model on which the national non-natural mortality surveillance system (currently being developed by the MRC, UNISA and the CSIR) is based.

The data for each mechanism of death category (see section 3.1.) were extracted into a separate EPI-INFO data file. The death register identification numbers were used to locate autopsy reports in the archives of the Departments of Forensic Medicine at the Universities

of Cape Town and Stellenbosch. Time of injury data for all deaths were extracted from ancillary documentation attached to the autopsy reports. Each of the railway fatalities was matched, where possible, with corresponding MOSA and OHSA reports from the Metrorail database in order to improve the accuracy of the *mechanism of death* variable, and to ascertain whether the fatality was a passenger or pedestrian fatality.

3.4. Population and Sampling

A railway census conducted during the sampling period (1995) revealed that more than 300 000 people use the metropolitan rail system daily (A. van Rensburg, Metrorail Risk Manager - personal communication). However, it was not possible to obtain an accurate estimation of the population at risk of rail-related death, as inhabitants living in the vicinity of the railway lines have to be taken into account, as well as commuters. There were more than 100 deaths annually in Cape Town between 1994 and 1996 for rail-related injuries (intentional and unintentional), more than 100 fatalities among both *MV drivers* and *MV passengers* and more than 500 fatalities for *MV pedestrians* (Matzopoulos, 1994; Lerer et al, 1995, Cape Town Non-Natural Mortality Study Group, 1996). However, the number of cases was considerably reduced in this study by the selection criteria below.

3.4.1. Exclusion criteria

- the exclusion of fatalities due to the late effects of the injury (more than 6 hours after the injury), as blood alcohol measurements were not routinely collected,
- the exclusion of fatalities that were intentionally inflicted or where the mechanism of death was unclear (particularly among railway fatalities),
- the exclusion of fatalities to minors (< 18 years), as BAC measurements were not routinely collected.

⁴ The Machinery and Occupational Safety Act of 1983 was recently replaced by the Occupational Health and Safety Act of 1995.

- the exclusion of fatalities that occurred between 19h00 and 06h00, to improve data quality as described in section 3.9.

A pilot study was undertaken, which compared BAC in MV passenger and railway passenger fatalities. As the original design of the project was intended to be a cross-sectional descriptive study with an analytic component, samples from each group were compared pairwise. A difference in mean BAC of 0.05 g/100ml was deemed to be a meaningful difference, as 0.05 g/100ml is the legal limit for driving a motor-vehicle in many industrialised countries. A sample size of 76 persons was the smallest required to detect a difference between means of 0.05 g/100ml in each group, with the power of the test at 80% and the significance level at 5%. The required sample sizes are shown in Table 1.

Table 1. Sample size requirements

<i>Difference (g/100ml)</i>	Beta		
	0.6	0.7	0.8
0.02	297	374	475
0.03	132	166	211
0.04	74	93	119
0.05	47	60	76

The small rail passenger fatality sample was compensated by larger samples for the other categories. In the case of MV pedestrian fatalities, where there were considerably more fatalities (more than 500 per year), every third record was reviewed sequentially for inclusion in the study.

3.5. Data description

Blood alcohol concentration was defined as the dependent variable, while the independent variables were age, sex, race, date of death, day of week, time of injury and mechanism of death. It was suspected that there were other variables that would have a potential

confounding or modifying effect, such as risk-taking behaviour and the use of narcotics, but these could not be determined from the autopsy reports. The following data set was available for analysis (Table 2):

Table 2. Description of variables

Name	Field description	Type	Example
DR	Death register no.	Unique	1092
MORT	Mortuary	identifiers	1= Salt River; 2=Tygerberg
YOD	Year of death	Ordinal	4=1994; 5=1995; 6=1996
AGE	Age	Continuous	1...99
SEX	Sex	Categorical	1= male; 2=female
RACE	Race	Categorical	1=black; 2=coloured;3=white
TOD	Time of day	Ordinal	19 (between 18h01 and 19h00)
DOW	Date of week	Continuous	Mon, Tue calculated from date of death
MOD	Mechanism of death	Categorical	1 = <i>railway passenger</i> fatality
BAC	Blood alcohol concentration	Continuous	0.22 (g/100ml)
AGECAT	Age categories	Ordinal	<=29 =1 30-39 =2 40-49 =3 50-59 =4 >=60 =5
TIMECAT	Time of day categories	Categorical	07h00-11h59 =1 12h00-15h59 =2 16h00-19h00 =3

The key variables of the study are discussed below:

3.5.1. Death register number, mortuary and year of death

The combination of these three variables forms a unique identifier for each death.

3.5.2. Sex

The deceased were classified as *male* or *female*.

3.5.3. Age

Data was collected for adults, aged 18 years and older. Children and adolescents younger than 18 years were excluded from the study, because BAC is not routinely checked in these cases.

3.5.4. Race

The terminology *black*, *coloured* and *white* are used in this study, the classification being based on previous "official" usage. Currently, health status cannot accurately be described without recourse to historical racial terminology, which does not imply their legitimacy. In this study, race is used as a proxy variable for socio-economic status in the absence of a more suitable indicator. Social, economic and political institutions in South Africa were, until recently, structured along these legally defined "racial" categories and therefore the use of race remains the most appropriate methodology for highlighting a range of disparities.

3.5.5. Date and day of death

The date of death was the same as the date of injury. Fatalities due to the late effects of trauma, i.e. where the date of injury preceded the date of death, were excluded from the study.

3.5.6. Day of week

Day of week was calculated from the date of death by converting the EPI-INFO data file into a Quattro Pro (Corel Corporation 1997) spreadsheet and running a conversion macro.

3.5.7. Time of injury

Time of injury was extracted from SAP 180 forms attached to the autopsy reports. The SAP 180 forms are completed by police officers on reporting an injury or death. The forms specify the date, time and type of injury, as well as the personal details of the injured person. In certain cases the time of injury differed from the time of death. If the difference between the time of injury and the time of death exceeded 6 hours, the case was not included in the study, since BACs are not routinely measured for deaths due to the late effects of injury.

3.5.8. Mechanism of death

The mechanism of death categorisation is based on external injury codes as defined in the ICD-9 (WHO, 1978). The MV driver, MV passenger and MV pedestrian categories, which corresponded with ICD codes E819, E815 and E814 respectively, comprised road traffic fatalities on public roads, who had died as a result of their injuries. All rail fatalities were categorised as ICD category E807. This category was sub-divided into two groups: rail passenger fatalities, comprising commuters who were killed either by falling out of the train, or becoming trapped between the train and the station platform, and railway pedestrian fatalities, comprising commuters or people who strayed across the railway lines and were struck by trains. Intentional fatalities due to violence or self-inflicted (as in the case of railway suicides) were excluded from the study. The exclusion criteria (section 3.4) and the allocation of deaths to a *mechanism of death* category are described in more detail in section 3.9.

3.5.9. Blood alcohol concentration

Blood was analysed for alcohol concentration, using standard headspace gas chromatography, at the State Chemical Laboratory in Cape Town. Results were attached to

autopsy reports at the Forensic Medicine archives at the Universities of Cape Town and Stellenbosch. BAC was stratified into two binary categories for analysis: unintoxicated ($BAC < 0.05$) and intoxicated ($BAC \geq 0.05$).

3.6. Data cleaning

Records were removed from the database if they did not comply with the selection criteria for the study (as described in section 3.4). The data were also checked for completeness using the EPI-INFO frequency count function and the appropriate values were substituted if missing or incorrect values were identified.

3.7. Analysis

The data were analysed using Epi-Info version 6 (Dean et al 1990) and the SAS System statistical analysis software (Statistical Analysis Support System 1990). Epi-Info was used to generate frequency counts and descriptive statistics. The SAS univariate procedure was used to generate the odds-ratios (OR) and confidence intervals for each variable. The SAS logistic regression procedure was used for multivariate analysis. The categorical and ordinal explanatory variables were recoded using dummy variables to test for significant relationships with the dependent variable BAC (recoded as a binary variable; 0=unintoxicated, 1=intoxicated).

The odds ratio (OR) was used as the measure of relative risk. The selection procedure used *alpha* and *beta* values of 0.05 and 0.8 respectively.

3.8. Ethics

The four basic principles of biomedical ethics, namely respect for persons, beneficence, non-maleficence and justice were upheld in this study. The study design made use of

secondary data sources in the form of Metrorail and mortuary records. Complete confidentiality was maintained and the data were used solely and exclusively for this study. The study conformed to accepted ethical practices for biomedical research (South African Medical Research Council, 1993). Ethical approval granted by the University of Cape Town Ethics Committee is attached in Appendix 2, and the research agreement between Metrorail and the MRC in Appendix 3.

3.9. Data Quality

The classification of a death as either an 'MV pedestrian, MV passenger, or MV driver' fatality was based on the allocation of an International Classification of Disease (ICD) code, which described the external cause of injury (WHO 1993). For the motor vehicle groups, the corresponding ICD codes were E814, E815 and E819 respectively. However, all railway fatalities were classified broadly under one category: E807 'railway fatality'. The coding did not take into account whether the deceased was a railway passenger or railway pedestrian fatality, nor the circumstances of the death with respect to intent. It was possible to determine from the autopsy reports whether the fatality was a passenger or pedestrian, but there was seldom clarity as to whether the case was unintentional, self-inflicted or violence-related.

The exclusion criterion for intentional, self-inflicted or undetermined fatalities applied mainly to the exclusion of violence and suicide fatalities from the 'railway fatalities', although one MV fatality who had suffered a heart attack prior to the fatal collision was excluded. For 'railway fatalities' the accuracy of the information pertaining to the circumstances of death was largely dependent on the reliability of the Metrorail MOSA and OHSA records (section 3.3). Metrorail personnel routinely completed these forms at the time of the incident. As Metrorail personnel were not always present when the incidents took place, the information recorded was often based on communication volunteered by eyewitnesses. This was

particularly important for determining whether passengers who had been fatally injured had fallen due to overcrowding, which would satisfy the conditions for inclusion in the study, or had been pushed out of the train, which would require their exclusion due to their injuries being intentionally inflicted.

Site visits to the railway system and interviews with train-drivers revealed that Metrorail train drivers and ticket collectors experienced fears for their personal safety and had to be escorted by security staff on some of the railway lines. Metrorail staff felt particularly threatened at night (Johann de Koker, train driver - personal communication), and were unwilling to approach members of the public for information. For this reason, it was felt that the mechanism of death information recorded in the MOSA and OHSA forms would only be recorded with reasonable accuracy for daytime injury events. The exclusion criterion was designed primarily to restrict the railway passenger fatalities to daytime hours, when the descriptions of the event were more reliable and hence improve the accuracy of the mechanism of death variable.

4. RESULTS

4.1. Selection of Cases

Death records were reviewed for 399 rail (passenger and pedestrian), 369 MV passenger, 666 MV pedestrian and 325 MV driver fatalities. Details of exclusions due to the criteria listed in Section 3.4 are shown in Table 3.

Table 3. Number of cases excluded.

Year	Mortuary	Total records reviewed	Number excluded due to:			Cases included
			Late effects	Age	Time	
Railway fatalities						
1994	Tygerberg	18	3	2	0	13
	Salt River	106	10	6	36	54
1995	Tygerberg	41	2	3	3	33
	Salt River	87	4	4	22	57
1996	Tygerberg	38	1	3	14	20
	Salt River	109	14	7	12	66
Total		389	34	25	87	243
MV passenger fatalities						
1994	Tygerberg	42	9	7	18	8
	Salt River	62	18	4	23	17
1995	Tygerberg	51	9	7	25	10
	Salt River	74	29	3	27	15
1996	Tygerberg	31	9	3	14	5
	Salt River	109	23	7	47	32
Total		369	97	31	154	87
MV pedestrian fatalities						
1994	Tygerberg	97	32	11	31	23
	Salt River	132	26	21	60	25
1995	Tygerberg	81	22	12	32	15
	Salt River	129	28	26	55	20
1996	Tygerberg	55	10	7	25	13
	Salt River	172	39	26	68	39
Total		666	157	103	271	135
MV driver fatalities						
1994	Tygerberg	17	1	0	14	2
	Salt River	41	10	0	25	6
1995	Tygerberg	78	24	0	41	13
	Salt River	74	16	0	35	23
1996	Tygerberg	33	8	0	14	11
	Salt River	82	16	0	43	23
Total		325	75	0	172	78
Total # records reviewed		1749	363	159	684	543

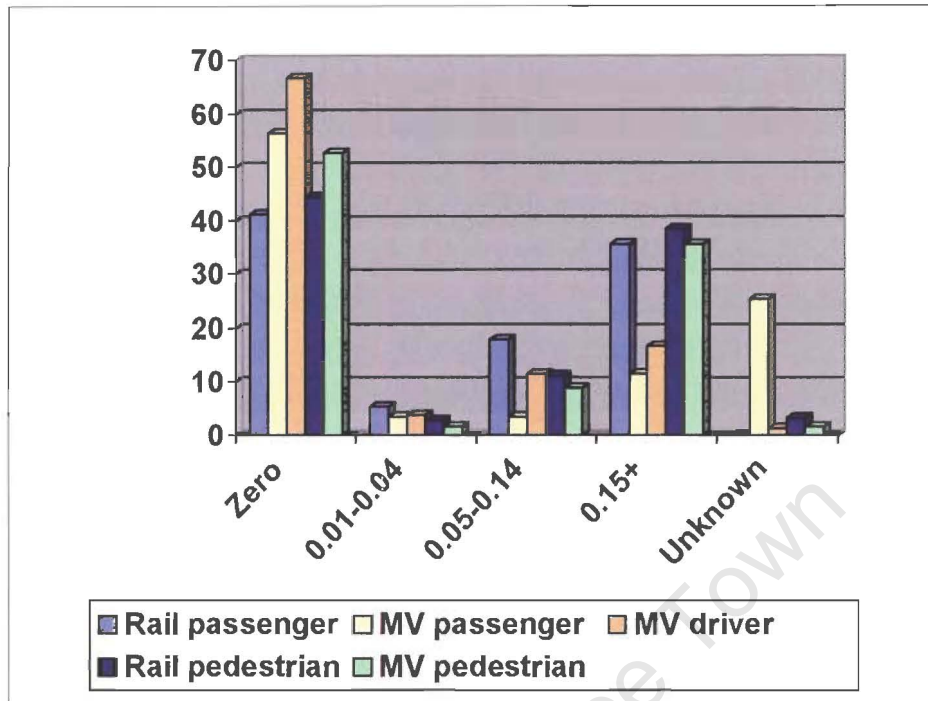
In total 1216 fatalities were excluded from the study due to the late effects of injury, the deceased being too young for blood alcohol testing and the deaths occurring between 19h00 and 07h00. The time of day exclusion criterion, which was the reason for the exclusion of more than half of the fatalities (684 out of 1216), was clearly justified, as a much smaller proportion of railway fatalities were excluded (only 22% of the total railway fatality cases reviewed).

The final sample consisted of 543 cases, of which 56 were railway passengers, 187 railway pedestrian, 87 MV passenger, 135 MV pedestrian and 78 MV driver fatalities. BACs were available for 512 of the fatalities (94%), including 56 (100%) of the railway passenger, 181 (97%) of the railway pedestrian, 65 (75%) of the MV passenger, 133 (99%) of the MV pedestrian and 77 (99%) of the MV driver fatalities. There was 100% recording of all the dependent variables: mechanism of death, age, sex, race, date (and hence day of death) and time of death.

4.2. Relationship of BAC with Explanatory Variables

Figure 2 shows the percentage of cases with BAC levels of 0.00 g/100ml, 0.00 to 0.04 g/100ml, 0.05 to 0.14 g/100ml and greater than 0.015 g/100ml for each cause of death.

Figure 2. Distribution of BAC level (percent) by cause of death



While substantial proportions had zero levels (40-70%), the results show that rail passengers and pedestrians, together with MV pedestrians, had higher levels of BAC than the MV passengers and MV drivers. For each cause of death, significant relationships between potential covariates and BAC were investigated by stratifying the data according to cause of death and comparing levels of intoxication in the different strata. A BAC cut-off of 0.05g/100ml was used⁵.

4.2.1. BAC and year of death

Table 4 shows the relationship between intoxication and year of death. The distribution of intoxicated fatalities was not significantly different in the three years, as shown by the Cochran-Mantel-Haenszel X^2 test for general association. However, the percentage of

⁵ Statistics differ according to the stratification criteria for BAC: BAC positive (greater than 0.00 g/100ml), intoxication (BAC greater or equal to 0.05 g/100ml). The following analysis was restricted to the intoxication stratification for clarity and brevity.

intoxicated fatalities over the three year period was significantly different among *MV passenger* fatalities due to a very low proportion of intoxicated fatalities in 1996.

Table 4. Proportion of intoxicated fatalities by cause of death and year of death.

Cause of death	N	%	Test Statistic	p-value
Rail passenger*				
1994	16	56	$X^2_2 = 0.68$	0.713
1995	25	44		
1996	15	53		
Rail pedestrian*				
1994	47	47	$X^2_2 = 0.27$	0.875
1995	64	52		
1996	70	51		
MV passenger*				
1994	21	33	$X^2_2 = 6.81$	0.033
1995	19	26		
1996	25	4		
MV driver*				
1994	8	13	$X^2_2 = 1.65$	0.439
1995	35	34		
1996	34	26		
MV pedestrian*				
1994	48	40	$X^2_2 = 3.87$	0.144
1995	34	59		
1996	51	39		
<i>General Association</i>			<i>Cochran- Mantel-Haenszel</i>	$X^2_2 = 2.245$ 0.325

* More than 25% of the cells have expected counts less than 5, which affects the validity of the X^2 test.

4.2.2. BAC and sex

Table 5 shows the relationship between alcohol intoxication and sex. The percentage of intoxicated fatalities for male and female fatalities was not significantly different for any specific cause of death. This was supported by the Breslow-Day Test, which showed that the ORs for each cause of death were homogenous ($X^2_4 = 8.689$; $p = 0.069$).

The distribution of intoxicated fatalities among males and females was not significantly different for the various causes of death, as shown by the Cochran-Mantel-Haenszel X^2 test for general association. Although there was a difference among rail passengers, there were

too few female cases for this difference to be significant. The distribution of male and female deaths followed a similar pattern among MV driver and MV passenger fatalities. However, further analysis, which combined both these categories of traffic users showed that the percentage of intoxicated male fatalities was significantly higher (Mantel-Haenszel $X^2 = 6.02$; $p=0.014$).

Table 5. Proportion of intoxicated fatalities by cause of death and sex.

Cause of death	N	%	Test Statistic	p-value
Rail passenger*				
Male	50	46	Fisher's Exact test	0.193
Female	6	83		
Rail pedestrian				
Male	149	50	Mantel-Haenszel $X^2_1 = 0.001$	0.973
Female	32	50		
MV passenger*1				
Male	41	27	Fisher's Exact test	0.109
Female	24	8		
MV driver*				
Male	57	33	Fisher's Exact test	0.155
Female	20	15		
MV pedestrian				
Male	95	43	Mantel-Haenszel $X^2_1 = 0.193$	0.660
Female	38	47		
<i>General Association</i>			<i>Cochran-Mantel-Haenszel $X^2_1 = 0.299$</i>	<i>0.585</i>

* Some of the cells have expected counts less than 5, hence the use of Fisher's exact test.

4.2.3. BAC and age

Table 6 shows the relationship between intoxication and age. The distribution of intoxicated fatalities in the four age categories was significantly different for the various causes of death, as shown by the Cochran-Mantel-Haenszel X^2 test for general association. This was largely due to the relatively high proportion of intoxicated fatalities in the older age categories (> 50 years) of the two groups of pedestrian fatalities compared to a low proportion of older intoxicated fatalities for the other causes of death.

Furthermore, the percentage of intoxicated fatalities in the four age categories was significantly different among MV driver and railway passenger fatalities. The age groups with the highest percentage of intoxicated fatalities were the <29 years age group for MV drivers and 30-39 years for MV passengers. Both MV driver and MV passenger fatalities showed a low percentage of intoxicated fatalities in the older age category.

Table 6. The proportion of intoxicated fatalities by cause of death and age.

Cause of death	N	%	Test Statistic	p-value
Rail passenger*				
<29	22	36	$X^2_3 = 13.71$	0.003
30 – 39	17	65		
40 – 49	7	100		
> 50	10	20		
Rail pedestrian				
<29	59	39	$X^2_3 = 5.56$	0.135
30 – 39	55	53		
40 – 49	40	63		
> 50	27	52		
MV passenger*				
<29	19	26	$X^2_3 = 5.7$	0.13
30 – 39	15	33		
40 – 49	17	18		
> 50	14	0		
MV driver				
<29	26	42	$X^2_3 = 8.57$	0.036
30 – 39	18	33		
40 – 49	12	33		
> 50	21	5		
MV pedestrian				
<29	27	30	$X^2_3 = 1.92$	0.59
30 – 39	44	42		
40 – 49	28	46		
> 50	34	44		
General Association			Cochran- Mantel-Haenszel $X^2_3 = 13.259$	0.004

* More than 25% of the cells have expected counts less than 5, which affects the validity of the X^2 test.

4.2.4. BAC and race

Table 7 shows the relationship between intoxication and race. The distribution of intoxicated fatalities among black, coloured and white fatalities was not significantly different for the various causes of death, as shown by the Cochran-Mantel-Haenszel X^2 test for general association. Furthermore, the percentage of intoxicated fatalities among black, coloured and white fatalities was not significantly different for any specific cause of death. The difference was most pronounced among MV pedestrian fatalities, but there were too few white fatalities for the difference to be significant.

Table 7. The proportion of intoxicated fatalities by cause of death and race.

Cause of death	N	%	Test Statistic	p-value
Rail passenger*				
Black	34	53	$X^2_2 = 0.32$	0.853
Coloured	20	45		
White	2	50		
Rail pedestrian*				
Black	97	49	$X^2_2 = 0.4$	0.818
Coloured	79	52		
White	5	40		
MV passenger*				
Black	16	19	$X^2_2 = 0.62$	0.735
Coloured	40	23		
White	9	11		
MV driver*				
Black	9	33	$X^2_2 = 0.15$	0.929
Coloured	31	29		
White	37	27		
MV pedestrian				
Black	57	47	$X^2_2 = 4.9$	0.086
Coloured	63	48		
White	13	15		
<i>General Association</i>			<i>Cochran- Mantel-Haenszel $X^2_2 = 3.289$</i>	<i>0.193</i>

* More than 25% of the cells have expected counts less than 5, which affects the validity of the X^2 test.

4.2.5. BAC and day of the week

Table 8 shows the relationship between intoxication and day of week. The distribution of intoxicated fatalities was significantly different for the various causes of death, as shown by the Cochran-Mantel-Haenszel X^2 test for general association. Sunday had the highest percentage of intoxicated fatalities for rail pedestrian, MV passenger and MV pedestrian fatalities, while Monday and Friday had the highest percentage for rail passenger and MV driver fatalities respectively. It is also interesting to note the low number of Sunday fatalities among the two rail groups. The percentage of intoxicated fatalities in specific commuter categories was significantly different for rail passenger and rail pedestrian fatalities.

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Table 8. The proportion of intoxicated fatalities by cause of death and day of week.

Cause of death	N	%	Test Statistic	p-value
Rail passenger*				
Monday	6	67	$X^2_6 = 19.57$	0.003
Tuesday	7	29		
Wednesday	10	30		
Thursday	6	0		
Friday	15	53		
Saturday	8	88		
Sunday	4	100		
Rail pedestrian				
Monday	36	33	$X^2_6 = 16.5$	0.011
Tuesday	23	43		
Wednesday	23	57		
Thursday	26	31		
Friday	30	70		
Saturday	29	66		
Sunday	14	57		
MV passenger*				
Monday	6	0	$X^2_6 = 11.7$	0.069
Tuesday	7	0		
Wednesday	11	9		
Thursday	8	25		
Friday	6	0		
Saturday	11	27		
Sunday	16	44		
MV driver*				
Monday	5	60	$X^2_6 = 10.89$	0.092
Tuesday	6	17		
Wednesday	13	8		
Thursday	13	38		
Friday	17	12		
Saturday	15	53		
Sunday	8	25		
MV pedestrian				
Monday	19	26	$X^2_6 = 10.94$	0.09
Tuesday	15	20		
Wednesday	16	44		
Thursday	16	44		
Friday	18	50		
Saturday	28	50		
Sunday	21	67		
<i>General Association</i>			<i>Cochran- Mantel-Haenszel $X^2_6 = 32.08$</i>	<i>0.001</i>

* More than 25% of the cells have expected counts less than 5, which affects the validity of the X^2 test.

4.2.6. BAC and time of death

Table 9 shows the relationship between intoxication and time of death. The distribution of intoxicated fatalities between the three time categories was significantly different for the various causes of death, as shown by the Cochran-Mantel-Haenszel X^2 test for general association. This was due to the proportion of intoxicated rail fatalities increasing later in the day, while the proportion of intoxicated cases peaked at different times among the motor vehicle fatalities.

Table 9. The proportion of intoxicated fatalities by cause of death and time of death.

Cause of death	N	%	Test Statistic	p-value
Rail passenger*				
07h00 – 10h59	15	33	$X^2_2 = 2.28$	0.32
11h00 - 15h59	9	56		
16h00 - 19h00	32	56		
Rail pedestrian*				
07h00 – 10h59	66	29	$X^2_2 = 20.45$	<0.001
11h00 - 15h59	34	53		
16h00 - 19h00	80	66		
MV passenger*				
07h00 – 10h59	21	29	$X^2_2 = 5.81$	0.055
11h00 - 15h59	17	00		
16h00 - 19h00	27	26		
MV driver*				
07h00 – 10h59	25	40	$X^2_2 = 4.40$	0.111
11h00 - 15h59	23	13		
16h00 - 19h00	29	31		
MV pedestrian*				
07h00 – 10h59	35	26	$X^2_2 = 7.36$	0.025
11h00 - 15h59	25	44		
16h00 - 19h00	73	53		
<i>General Association</i>			<i>Cochran- Mantel-Haenszel $X^2_2 = 20.641$</i>	<i>0.001</i>

* More than 25% of the cells have expected counts less than 5, which affects the validity of the X^2 test.

Furthermore, the percentage of intoxicated fatalities in the three time categories was significantly different among rail pedestrian and MV pedestrian fatalities. Both groups showed an increased percentage of intoxicated fatalities later in the day. It is interesting to

note that sample sizes for these causes of death were considerably greater and that the considerable variation in the percentage of intoxicated fatalities among the other causes of death (particularly MV driver and MV passenger) might also have been significant if the sample size had been bigger. This can be demonstrated by combining the MV driver and MV passenger data, which had similar distributions of intoxicated cases. The χ^2 statistic of 9.34 was significant ($p=0.009$).

4.3. Rail Passenger versus MV Passenger Fatalities

BAC data were available for all rail passenger fatalities and only 74% of MV passenger fatalities (Table 10), as forensic pathologists did not routinely take MV passenger BAC in the case of fatalities due to public transport collisions involving taxis and buses.

Table 10. Distribution of BAC testing among rail passenger and MV passenger fatalities.

	Rail passenger (n=56)	MV passenger (n=87)
BAC available	100%	74%

The unadjusted ORs for alcohol consumption ($BAC \geq 0$ g/100ml) and intoxication ($BAC \geq 0.05$ g/100ml) among rail passenger versus MV passenger fatalities are shown in Table 11. Both ORs are significant and it was clear that the odds ratios differed according to the stratification criteria for BAC, either BAC positive (BAC greater or less than 0.00 g/100ml) or intoxication (BAC greater or less than 0.05 g/100ml).

Table 11. Unadjusted ORs for rail passenger and MV passenger fatalities

	Rail (n=56)	MV (n=65)	OR	95% CI
$BAC > 0.00$ g/100ml	59%	25%	4.39	2.02; 9.55
$BAC > 0.05$ g/100ml	50%	20%	4.00	1.79; 8.92

Table 12 shows the univariate analysis for the association between the two causes of death rail passenger and MV passenger for each of the covariates. The significant covariates were age, sex, race, day of week and time of day.

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Table 12. Background characteristics of rail passenger and MV passenger fatalities.

Variable	Rail (n=56)	MV (n=87)	Test statistic	p-value
Average AGE (s.d.)	34.5 (12.48)	39.9 (15.45)	$t_{141} = 2.16$	0.033
SEX (<i>male</i>)	89%	56%	$M-H \chi^2_1 = 17.3$	0.001
(<i>female</i>)	11%	44%		
RACE (<i>black</i>)	61%	35%	$\chi^2_2 = 10.5$	0.005
(<i>coloured</i>)	36%	53%		
(<i>white</i>)	4%	13%		
YOD (<i>1994</i>)	29%	29%	$\chi^2_2 = 4.8$	0.091
(<i>1995</i>)	45%	29%		
(<i>1996</i>)	27%	43%		
DOW (<i>Monday</i>)	11%	20%	$\chi^2_6 = 15.32$	0.017
(<i>Tuesday</i>)	13%	10%		
(<i>Wednesday</i>)	18%	13%		
(<i>Thursday</i>)	11%	12%		
(<i>Friday</i>)	27%	8%		
(<i>Saturday</i>)	14%	15%		
(<i>Sunday</i>)	7%	23%		
Average TIME (s.d.)	15.2 (4.1)	13.5 (4.0)	$t_{141} = 2.809$	0.006

A stepwise logistic regression model was fitted with all six covariates included in the initial model (Table 13). Backward selection was used with the p-value for removal set at a level of 0.05. The final model included sex, race and day of week as covariates, with an odds ratio for BAC = 5.23 (CI: 1.99 to 13.70).

Table 13. Logistic regression model for rail passenger and MV passenger fatalities.

Variable	Full model	Final model
AGECAT (<i>10 yrs</i>)	1.01 (0.97 – 1.04)	-
SEX (<i>female</i>)	3.89 (1.19 – 12.71)	3.48 (1.13 – 10.67)
RACE	0.35 (0.16 – 0.75)	0.34 (0.16 – 0.72)
DOW	0.78 (0.61 – 0.99)	0.76 (0.60 – 0.97)
TIME	1.08 (0.97 – 1.20)	-
YOD	1.03 (0.58 – 1.81)	-
BAC	4.71 (1.72 – 12.88)	5.23 (1.99 – 13.70)
-2 LOG L	127.83 (df=7)	130.02 (df=4)

Further analysis showed that sex modifies the effect between BAC and cause of death ($p = 0.024$), with a much larger OR for females than for males (Table 14). It is clear that the significant relationship between BAC and the rail passenger fatalities is a result of the high

BAC of the female passengers in the rail group. The OR of 2.03 for males was still not significant (CI: 0.802 to 5.111) and the OR for female fatalities of 55 remained significant (CI: 4.129 to 732.65) although the small sample size resulted in a wide confidence interval (see sample size calculations in discussion).

Table 14. Adjusted odds ratios for male and female passenger fatalities.

Variable	OR	95% CI
OR male	2.00	0.780; 5.120
OR female	78.25	5.293; 999.000

4.4. Rail Passenger versus MV Driver Fatalities

BAC data were available for all rail passenger fatalities and 99% of MV driver fatalities (Table 15).

Table 15. Distribution of BAC testing among rail passenger and MV driver fatalities.

	Rail passenger (n=56)	MV driver (n=78)
BAC available	100%	99%

The unadjusted ORs for alcohol consumption (BAC \geq 0 g/100ml) and intoxication (BAC \geq 0.05 g/100ml) among rail passenger versus MV driver fatalities are shown in Table 16. Both ORs are significant and it was clear that the odds ratios differed according to the stratification criteria for BAC, either BAC positive (BAC greater or less than 0.00 g/100ml) or intoxication (BAC greater or less than 0.05 g/100ml).

Table 16. Unadjusted ORs for rail passenger and MV passenger fatalities.

	Rail (n=56)	MV (n=77)	OR	95% CI
BAC>0.00g/100ml	59%	32%	2.98	1.46; 6.1
BAC>0.05g/100ml	50%	29%	2.50	1.22; 5.14

Table 17 shows the univariate analysis for the association between the two causes of death rail passenger and MV passenger for each of the covariates. The significant covariates were age, sex, race, year of death and time.

Table 17. Univariate analysis for rail passenger and MV driver fatalities.

Variable	Rail (n=56)	MV (n=78)	Test statistic	p-value
Average AGE (s.d.)	34.5 (12.48)	39.9 (16.48)	$t_{132} = 2.06$	0.042
SEX (<i>male</i>)	89%	74%	$M-H \chi^2_1 = 4.61$	0.032
(<i>female</i>)	11%	26%		
RACE (<i>black</i>)	61%	12%	$\chi^2_2 = 49.96$	0.001
(<i>coloured</i>)	36%	40%		
(<i>white</i>)	4%	49%		
YOD (1994)	29%	10%	$\chi^2_2 = 8.64$	0.013
(1995)	45%	46%		
(1996)	27%	44%		
DOW (<i>Monday</i>)	11%	6%	$\chi^2_6 = 3.75$	0.71
(<i>Tuesday</i>)	13%	8%		
(<i>Wednesday</i>)	18%	17%		
(<i>Thursday</i>)	11%	17%		
(<i>Friday</i>)	27%	22%		
(<i>Saturday</i>)	14%	21%		
(<i>Sunday</i>)	7%	10%		
TIME	15.2 (4.1)	13.7 (4.0)	$t_{132} = 1.992$	0.048

A stepwise logistic regression model was fitted with all six covariates included in the initial model (Table 18). Backward selection was used with the p-value for removal set at a level of 0.05. The final model included race and year of death as covariates, with an odds ratio for BAC = 2.27(CI: 0.90 to 5.77).

Table 18. Logistic regression model for rail passenger and MV driver fatalities.

Variable	Full model	Final model
AGECAT (10 yrs)	1.00 (0.96 – 1.04)	-
SEX (female)	1.60 (0.41 – 6.26)	-
RACE	0.13 (0.06 – 0.28)	0.12 (0.06 – 0.26)
DOW	0.81 (0.63 – 1.05)	-
TIME	1.06 (0.94 – 1.19)	-
YOD	0.41 (0.21 – 1.82)	0.39 (0.20 – 0.75)
BAC	2.61 (0.97 – 7.02)	2.27 (0.90 – 5.77)
-2 LOG L	113.55 (df=7)	117.36 (df=3)

The adjusted OR for the model with the remaining variables (race and year of death) implied that rail passenger fatalities were 2.27 times more likely to be intoxicated than MV driver fatalities, although the OR was not significant. However the wide interval of the 95% confidence interval (0.90 to 5.77) suggests that the relationship would have been significant with a larger sample size.

4.5. Rail Pedestrian versus MV Pedestrian Fatalities

BAC data were available for 97% of rail pedestrian fatalities and 99% of MV pedestrian fatalities (Table 19).

Table 19. Distribution of BAC testing among rail pedestrian and MV pedestrian fatalities.

	Rail passenger (n = 187)	MV pedestrian (n = 135)
BAC available	97%	99%

The unadjusted ORs for alcohol consumption (BAC \geq 0 g/100ml) and intoxication (BAC \geq 0.05 g/100ml) among rail pedestrian versus MV pedestrian fatalities are shown in Table 20. Neither OR was significant and the odds ratios were similar for both stratification by BAC positive (BAC greater or less than 0.00 g/100ml) and intoxication (BAC greater or less than 0.05 g/100ml).

Table 20. Unadjusted ORs for rail pedestrian and MV passenger fatalities.

	Rail (n = 181)	MV (n = 133)	OR	95% CI
BAC>0.00g/100ml	54%	47%	1.35	0.84; 2.17
BAC>0.05g/100ml	50%	44%	1.27	0.81; 1.99

Table 21 shows the univariate analysis for the association between the two causes of death rail pedestrian and MV pedestrian for each of the covariates. The significant covariates were age, sex, race and year of death.

Table 21. Univariate analysis for rail pedestrian and MV pedestrian fatalities.

Variable	Rail (n = 187)	MV (n = 135)	Test statistic	p-value
Average AGE (s.d.)	36.8 (13.3)	41.0 (14.73)	$t_{320} = 2.66$	0.008
SEX (male)	81%	71%	M-H $X_{21} = 4.57$	0.032
(female)	19%	29%		
RACE (black)	54%	44%	$X_{22} = 8.66$	0.013
(coloured)	43%	47%		
(white)	3%	10%		
YOD (1994)	27%	36%	$X_{22} = 8.64$	0.013
(1995)	35%	26%		
(1996)	38%	38%		
DOW (Monday)	20%	14%	$X_{26} = 8.61$	0.197
(Tuesday)	13%	11%		
(Wednesday)	12%	12%		
(Thursday)	14%	13%		
(Friday)	16%	13%		
(Saturday)	16%	22%		
(Sunday)	8%	16%		
TIME	13.9 (4.01)	14.6 (3.68)	$t_{320} = 1.595$	0.112

A stepwise logistic regression model was fitted with all six covariates included in the initial model (Table 22). Backward selection was used with the p-value for removal set at a level of 0.05. The final model included age, race and day of week as covariates, with an odds ratio for BAC = 1.44 (CI: 0.89 to 2.31).

Table 22. Logistic regression model for rail pedestrian and MV pedestrian fatalities.

Variable	Full model	Final model
AGECAT (<i>10 yrs</i>)	0.98 (0.97 – 1.00)	0.98 (0.96 – 1.00)
SEX (<i>female</i>)	1.71 (0.98 – 2.98)	-
RACE	0.70 (0.47 – 1.05)	0.66 (0.45 – 0.98)
DOW	0.81 (0.77 – 0.97)	0.85 (0.76 – 0.96)
TIME	0.95 (0.89– 1.01)	-
YOD	1.14 (0.86 – 1.52)	-
BAC	1.62 (0.98 – 2.69)	1.44 (0.89 – 2.31)
-2 LOG L	401.82 (df=7)	408.23 (df=4)

The adjusted OR for the model with the remaining variables (race and year of death) implied that railway pedestrian fatalities were 1.44 times more likely to be intoxicated than MV pedestrian fatalities, although the OR was not significant.

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5. DISCUSSION

5.1. Interpretation of Results

The increase in fatalities presenting at Tygerberg mortuary between 1994 and 1995 was due to the re definition of local government boundaries, as well as the increasing settlement by rural people in the northern part of the city.

More than half of all railway pedestrian and railway passenger fatalities included in the study were intoxicated. Among the motor vehicle fatalities, intoxicated fatalities accounted for between 20% (MV passengers) and 43% (MV pedestrians) of all fatalities. Analysis of the relationship between year of death and alcohol intoxication showed that alcohol intoxication was considerably lower among MV passengers in 1996 and among MV drivers in 1994. This was probably a chance occurrence, as alcohol intoxication for the other commuter groups did not show much variability over the three-year period. Personal communication with trauma and injury experts did not reveal any public health interventions aimed at alcohol usage among MV passengers in 1996 or among MV drivers specifically in 1994 (M. Peden and J. van der Spuy – personal communication).

Analysis of the relationship between sex and alcohol intoxication showed that the proportion of intoxicated fatalities among male MV passengers and MV drivers was considerably higher than among female fatalities. This could be attributed to the younger age of male drivers and passengers. Analysis of age and alcohol intoxication demonstrated that both these commuter groups showed higher levels of intoxication amongst young commuters, while the two pedestrian fatality groups both had a higher proportion of intoxicated fatalities among older commuters. This could be attributed to risk-taking behaviour on the part of young male MV drivers and rail passengers. This was borne out by a field-trip to Cape

Town's Khayelitsha railway line, where young men leaned out of open doors, and hung on to the outside of carriages while the train was in motion.

There were no significant differences between race and alcohol intoxication for any of the commuter groups. However, the proportion of intoxicated fatalities for the different days of the week did differ significantly. Only the two pedestrian categories showed a high proportion of intoxicated fatalities for each day of the week. This could be explained by the fact that pedestrian fatalities affect the very poor and unemployed, who are at risk of being run over by cars and trains in the peri-urban communities where they reside. Alcohol abuse is rife in these communities and is the cause of a number of health and social problems. Rail passengers and MV passengers and drivers comprise a higher proportion of employed people who would be less likely to drink during the week.

The proportion of intoxicated cases for the three times of death (07h00 - 10h59, 11h00 – 15h59 and 16h00 – 19h00) differed significantly between the different commuter groups. The high proportion of intoxicated MV driver fatalities early in the day is more than likely the result of late night drinkers meeting the early morning rush hour traffic. Both rail and MV pedestrian categories showed significantly different proportions of intoxicated fatalities for the three times of death, with a steady increase later in the day. Again, this could be explained by the pedestrian fatalities affecting the very poor and unemployed, who visit shebeens and taverns in peri-urban communities during the day.

The results show a positive relationship between intoxication and rail fatalities, with the proportion of cases (rail fatalities) having a higher proportion of intoxicated fatalities than the control groups (MV fatalities) for all the comparison groups. Among passenger fatalities the unadjusted ORs of 4.0 and 2.5 (with MV passengers and MV drivers as the respective controls) were both significant, while for pedestrian fatalities the relationship was positive (OR = 1.27) but not significant (CI = 0.81; 1.99). The results imply that intoxicated rail

passengers were 4 times and 2.5 times more likely to become fatalities than MV passengers or drivers respectively. Among pedestrian fatalities the OR of 1.27 implied that railway pedestrian fatalities were 27% more likely to be intoxicated than MV pedestrian fatalities.

The most pronounced relationship was in the comparison of alcohol intoxication among rail passenger versus MV passenger fatalities. The odds ratio was the largest for all comparison groups, with the unadjusted OR of 4.00 and the adjusted OR of 5.23 both statistically significant at the 5% level. Sex, race and day of week were the significant covariates and it was clear that sex was also a significant effect modifier. Female railway passenger fatalities were 78 times more likely to be intoxicated than female MV passenger fatalities, while male railway passenger fatalities were only twice as likely to be intoxicated as male MV passenger fatalities and the odds ratio was not statistically significant.

The increased risk for intoxicated female railway passengers could be attributable to factors that were not included in the study. One of the problems encountered on the Cape Metrorail system is overcrowding, especially at peak travelling times. Women are likely to be more vulnerable to the pushing and shoving that takes place when commuters attempt to board the first available train, particularly if they are intoxicated. The result supports the recent initiative by Cape Metrorail of making available a limited number of carriages for women only (with the remaining carriages open to both sexes). This system is currently in operation in other major cities in the developing world such as Mumbai (Bombay) and Delhi in India.

Although the adjusted OR for rail passenger and MV driver fatalities was not statistically significant, the interval was fairly wide (0.9 to 5.77) and the odds ratio value of 2.27 was high enough to suggest a positive relationship. A larger sample size would more than likely have been significant. The statistically significant covariates were race and year of death. Race, as a proxy variable for income and socio-economic status, was expected to be a

significant covariate, as a higher percentage of coloureds and whites are car-owners than blacks, and few whites (the wealthiest group) travel by train. The unusual distribution of intoxicated fatalities among MV passengers and drivers stratified by year of death have already been dismissed as chance occurrences.

For pedestrian fatalities the adjusted odds ratio of 1.44 was higher than the unadjusted odds ratio (1.27) due to the important role played by the confounding variables, although neither OR was significant. The significant covariates were age, race and day of week. Both groups were similar in that the proportion of intoxicated fatalities were higher in the older age categories, but among rail pedestrians there were considerably more fatalities in the youngest age group (younger than 29 years). Race was significant due to the very low number of white rail pedestrian fatalities and for day of week, rail pedestrians showed a weekend peak in intoxicated fatalities on Friday and Saturday.

The consistently positive odds ratios for all the comparison groups indicate that alcohol intoxication plays an important role in rail fatalities. Even if the odds ratios for rail passenger versus MV driver fatalities, and rail pedestrian versus MV pedestrian fatalities were not statistically significant, it is clear that alcohol does not play a lesser role than in MV fatalities. After controlling for confounding, only the relationship between rail passenger and MV passenger fatalities remained significant, but it could be argued that larger sample sizes would have resulted in significant results for all the comparison groups.

5.2. Study limitations

The sample size was inadequate to generate statistically significant odds ratios for the comparison of railway passenger with MV driver fatalities and railway pedestrian versus MV pedestrian fatalities. The initial sample was intended to satisfy a cross-sectional descriptive study and had a case-control study been planned from the outset, a larger sample would have been required. Tables 23 and 24 show the optimal sample size requirements for the comparison of passenger and pedestrian fatalities respectively. The data were generated using the Epi-Info STATCALC function (Dean et al 1990), with the significance level and power set at 5% and 80% respectively.

Table 23. Optimal sample size for rail passenger versus MV driver fatalities.

Actual sample size for rail passenger versus MV driver fatalities				
OR range	% intoxicated		Actual sample size	
	cases	Controls	Cases	Controls
2.27 to 2.50	50	29	56	78

Optimal sample size with 1 control for each case		
OR	Required sample size	
	Cases	Controls
2.25	115	115
2.30	109	109
2.35	103	103
2.40	99	99
2.45	94	94
2.50	90	90
2.55	86	86

It is clear from Table 23 that more than 100 cases and controls were required for the adjusted OR of rail passenger versus MV driver fatalities to be statistically significant. This implies that more than 5 years of data from the Salt River and Tygerberg mortuaries would have been required.

Table 24. Optimal sample size for rail pedestrian versus MV pedestrian fatalities.

Actual sample size for pedestrian fatalities				
OR range	% intoxicated		Actual sample size	
	Cases	Controls	Cases	Controls
1.27 to 1.44	50	45	181	133

Optimal sample size with 2 controls for each case		
OR	Required sample size	
	Cases	Controls
1.25	977	1954
1.30	709	1418
1.35	544	1088
1.40	435	870
1.45	358	716

Table 24 shows the sample size requirement for the rail pedestrian versus MV pedestrian case control study, with two controls for every case. Assuming that the adjusted odds ratio of 1.44 was the final measure of association, a sample of approximately 360 cases and 720 controls would be optimal, representing approximately six years of mortality data from Salt River and Tygerberg mortuaries. This also requires that all motor vehicle pedestrian fatalities would need to be reviewed for inclusion in the study instead of only reviewing every third record.

The large sample size requirement means that the study would not have been feasible, as compilation of non-natural mortality data in an electronic format only started at the two Cape Town mortuaries in 1994 (Matzopoulos 1994). However, the current NIMSS data base involves the collection of non-natural mortality data from 15 mortuaries nationally, which would enable similar studies in the future.

The assumption that state mortuaries do not provide full coverage of non-natural fatalities has only been disputed for rural areas of South Africa (Bradshaw et al 1992). Although there is no gold standard for comparison, it can be assumed that at least state mortuaries

capture more non-natural fatalities than other available data sources. This is supported by data from the Central Statistical Services, where one of the largest categories of death is the "undetermined" group, a large proportion of which are due to non-natural causes (violence and injury). The reliability of mortuary records versus police statistics in Cape Town was highlighted in a study by Wigton (1999), which showed that for some months a fifth of all firearm-related deaths among children and adolescents seen in mortuaries were not recorded in police homicide statistics. Furthermore, Peden (1997) showed that not all MVA pedestrian fatalities were registered in the Traffic Accident database.

The low probability of death from rail-related injuries (<5 per 100 000 population in Cape Town) suggested that a case control study was the most appropriate design. Ideally, this would have required the selection of a control group of uninjured commuters being tested for BAC. Controlled studies have either studied the relationship between alcohol and injury severity, by comparing fatal cases and non-fatal controls (Clayton et al 1977) or matched by site of accident, and a combination of age, sex, time of day, day of week or season of year (Irwin et al 1983; Haddon 1961). The definitive case control study for investigating the characteristics of adult pedestrians fatally injured by motor vehicles was conducted by Haddon in 1961. Each case was matched with an individual control at the location of death. While this was technically possible for the current study, neither the selection of controls by injury severity (all cases were fatalities) or location were practical for the current study. The selection of controls by site of accident would be difficult logistically and would be prone to over-matching, and a number of biases. Overmatching would be due to the infrequency of incidents relative to the number of variables that would need to be matched - age, sex, race or socio-economic class, time of day, day of week, proximity to month-end, exact location of incident (station or part of line), and circumstances of injury event (e.g. as train entered station, on closing of the train doors, etc). Furthermore, the timing and the location of many of the incidents suggested that data collection could conceivably compromise the safety of

the field worker. Selection bias could not be ruled out by the field-worker, who would find it easier to test sober commuters and pedestrians for BAC. The selection of controls with lower BAC would show a strong positive correlation between the presence of alcohol in the blood and railway-related trauma. Selection bias due to non-intoxicated controls being more likely to volunteer for blood alcohol testing would also occur.

Initially, it was envisaged that a pseudo case-control study could be designed, by using rail commuter fatalities as cases and taxi passenger fatalities as controls, as the taxi passengers came from the same (or a very similar) commuter population. Unfortunately, upon preliminary investigation of motor vehicle fatality records, it was found that taxi passenger BAC was infrequently recorded. The control population including all MV passenger fatalities was selected. These represent a similar commuter population to railway passengers, as they are non-active "transportees" and not (possibly wealthy) car owners. Among *MV passenger* fatalities (and injuries), the exposure under investigation (alcohol intoxication) is not associated causally with the mechanism of death; i.e. alcohol does not cause an intoxicated passenger to be involved in a motor vehicle collision. However, an intoxicated MV passenger might be more likely to travel with an intoxicated MV driver, increasing their likelihood of being involved in a collision and becoming a MV passenger fatality (Soderstrom, Dischinger, Kerns, 1996).

This study was restricted by the availability of only a few of the explanatory variables from the data sources. Other variables, such as risk-taking behaviour and narcotics, would have been included in the analysis if they had been available. Furthermore, the validity of some of the variables was questionable. Mechanism of death for the rail fatalities was largely dependent on the Metrorail OHSa or MOSA records, which determined whether the death was allocated to the rail pedestrian or rail passenger category, or whether they were excluded from the study (deaths due to violence or suicide). OHSa/MOSA forms were completed by Metrorail personnel, who had no formal medico-legal training. Time of death

was taken from police documentation attached to the autopsy report, and were also used as exclusion criteria for the study (deaths occurring between 19h00 and 06h00). More cases were excluded because of the time of death than any other exclusion criterion.

Other studies have shown that patients affected by alcohol are more likely to be admitted in the late evening and early morning (Bradbury, 1991) and that BAC positive patients are more expensive to treat than their sober counterparts (Bradbury, 1991; Jehle & Cottingham, 1988; Jurkovitch, Rivara, Gurney et al, 1992).

It is possible that some railway pedestrian suicides (i.e. intentional deaths) were included among the pedestrian fatalities, but it is believed that these deaths comprise a very small proportion of railway pedestrian fatalities and the collation of mortality records with Metrorail OSHA forms will minimise the occurrence of these events. The dilution of the railway pedestrian category with possible suicides should not adversely affect the results of the study, as independent research has shown that intoxication is a good, but non-specific, indicator of accidental death rather than suicide with respect to railway fatality (Cina et al, 1994). It is expected that the inclusion of suicides would reduce the mean BAC and the proportion of cases with positive BAC and as such would be a non-differential misclassification.

Missing BAC data were attributable to the data not being recorded due to missing forensic records, damage to the sample bottles, or the blood sample being too small for analysis. This was not the case for MV passenger fatalities, where blood samples for alcohol and drug testing were not always taken by pathologists. This was particularly evident for deaths among taxi passengers.

When the NIMSS is implemented nationally, one of the anticipated outcomes is improved communication and transfer of data between state mortuaries and state chemical

laboratories, which will assist in the routine collection of alcohol and substance abuse data among all transport-related fatalities to assist in future comparative studies. Another anticipated outcome of the NIMSS will be the improved communication and transfer of data between police and ambulance services and the state mortuaries, which should improve the accuracy of information on the circumstances and the time of death. It is hoped that other utilities that collect injury data, such as Metrorail, will also provide information to the NIMSS.

Another major limitation was the time limit exclusion criteria, as alcohol levels are higher at night. Confounding caused by the different times of death could have been controlled using the multivariate procedure. Covering the whole 24 hour period might also have revealed other significant relationships, such as a correlation between darkness and rail fatalities similar to the one for darkness and MV pedestrians.

5.3. The Role of Alcohol

The National Highway Traffic safety Administration in the United States considers a fatal crash alcohol-related if either a driver or a non-occupant (i.e. pedestrian) had a BAC \geq 0.01 g/100 ml (Centre for Disease Control, 1994). The alcohol intoxication level of 0.05 g/100 ml used in this study is based on the current drink driving law (Republic of South Africa, 1989). This relates back to the Grand Rapids study, which described risk at different alcohol levels. The study showed that "blood alcohol concentrations (BACs) over 0.04 % are definitely associated with an increased accident rate. The probability of accident involvement increases rapidly at BACs over 0.08%, and becomes extremely high at BACs over 0.15%" (Borkenstein et al., 1964). The cut-off is used to highlight the important role that alcohol plays in rail fatalities at a level deemed to be significant by road transport policy makers.

The lower BAC among MV driver fatalities could be ascribed to the success of enforcing legal alcohol consumption limit regulations among drivers. Although BAC among all transport groups would have been considerably higher had night-time fatalities been included in the study. The results of the study clearly show that other transport users are as much of an increased risk as motor vehicle drivers whilst under the influence of alcohol. This is particularly evident among railway passengers and transport authorities need to put regulations in place to ensure that intoxicated passengers do not have access to rail systems.

The role of alcohol intoxication in both rail and motor vehicle pedestrian fatalities will require a broader community oriented approach. Participatory research inspired massive community action to reduce alcohol consumption in India's Maharashtra State (Bang & Bang 1991), and other successful prevention programmes to reduce alcohol consumption have also been documented (Parry & Bennetts, 1998; Edwards, Anderson, Barbor, 1994; Room, Carlini-Cotrim, Gureye, et al, 2000).

This study does not investigate the relationship of alcohol use in combination with other drugs. These are potential confounders for estimating the risk between alcohol and transport-related mortality, but are more likely to be interacting variables. The use of marijuana and cocaine have been identified as a possible important cause of traffic injuries (Brookoff, Cook, Williams et al., 1994), while a study in Norway showed that psychoactive drugs were used by almost 30% of drivers suspected of DUI (Morland, Beylick, Bjorneboe, et al., 1995). However, more recent literature is beginning to show that cannabis alone does not increase the risk of motor-vehicle accidents, whereas alcohol and cannabis together are a problem (Waller, Blow, Maio et al 1997).

6. CONCLUSION

The findings of this project have shown that alcohol consumption is indeed an important risk-factor for railway-related fatalities. The design of the study meant that causality could not be inferred, but its biological plausibility and the consistency with other studies suggests that prevention strategies are necessary. The study complements a growing body of research that documents the adverse health effects of excessive alcohol consumption.

While it might be premature for Metrorail, in isolation, to take a stand on the issue of alcohol consumption on trains and at stations, the study provides more evidence for public health campaigners to tackle the issue of endemic alcohol abuse in South African communities. Prevention should focus on far-reaching health promotion and programs that mobilise communities against alcohol abuse. A framework has been developed by the anti-smoking lobbyists, who were able to motivate for legislation based on strong epidemiological evidence (World Health Organisation 1999). If the anti-alcohol movement follows the lead of the anti-tobacco lobby, we can expect bans on alcohol advertising and drinking in public places. This would require action from Metrorail, law enforcement and communities to reduce alcohol consumption.

The NIMSS, which is currently being piloted nationally, includes a category for rail-related injury and the modified form includes a railway category for the scene of injury. The study has demonstrated the utility of the NIMSS for case control studies, and it is hoped that this study will be a precursor for other analytic studies investigating risk factors for transport injuries.

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University of Cape Town

NMSS DATA COLLECTION FORM

Portuary _____ Police No. _____ Officer collecting body (Surname) _____

Case no. _____ PM Date

--	--	--	--	--	--	--	--

 Pathologist (Surname) _____

Date & Time of Injury

--	--	--	--	--	--	--	--

--	--

 Race

A	B	C	W	U
---	---	---	---	---

 Sex

M	F	U
---	---	---

Date & Time of Death

--	--	--	--	--	--	--	--

--	--

 Age

--	--

--	--

 Years Months

Medical treatment of injury prior to death (check only ONE) 1 None 2 Emergency care at scene 3 Hospital care

Province of injury (may differ to province of death) **Scene of injury (may differ to scene of death)**

1 Gauteng	7 Mpumalanga	1 Private house & yard (inc. pool)	9 Medical service area
2 W. Cape	8 Northern Province	2 Residential institute	10 Industrial & construction area, mine
3 K.Z. Natal	9 North West	18 Informal settlement/squatter camp	11 Farm, primary production area
4 E. Cape	10 Unknown	3 Bar, shebeen, N'Club, disco	12 Sea, lake, river, dam
5 N. Cape	11 Other (specify)	4 Amusement park, sports area	13 Open land, beach
6 Free State		5 Road/street/highway	14 Countryside
		6 Railway track, station	15 In custody, prison
		7 Shop, bank, retail area	16 Place unknown
		8 School, educational area	17 Other (specify)

Town of Injury _____

Suburb or District _____

External Cause or Circumstance of Injury

1 Firearm Discharge	9 Fall/push/jump from height	17 Motor vehicle Driver	24 Abandoned baby
2 Sharp Object	10 Other fall/push/jump	18 Motor vehicle Unspecified	25 Electrocutation
3 Blunt Object	11 Crushing	19 Railway casualty	26 Explosive blast
4 Strangulation, suffocation, asphyxia	12 Choking, aspiration	20 Bicycle, motor cycle	27 Natural cause
5 Hanging	13 Drowning, immersion	30 Aviation casualty	28 Unknown
6 Poisoning, ingestion	14 Lightning	21 Medical Procedure	29 Other Specific Cause
7 Poisoning, gassing	15 Motor vehicle Pedestrian	22 Sudden Infant Death	
8 Bum	16 Motor vehicle Passenger	23 Abortion, still birth	

Apparent Manner of Death

1 Homicide 2 Suicide 3 Accident 4 Natural 5 Undetermined

Samples Taken (check all)

1 None 2 Blood 3 Tissue 4 Other fluid

Alcohol and Other Substances (for completion by surveillance consortium staff)

Blood Alcohol Level

--	--	--	--

 Eye Fluid Alcohol

--	--	--	--

 Other Substances (Specify) _____

For completion following court investigation: homicides and suicides only

Type of Intentional Violence

Perpetrator -- Victim Relationship

1 Interpersonal	6 Rape, Sexual	1 Spouse, Partner	5 Friend	9 Unknown
2 Self Directed	7 Child Abuse	2 Parent	6 Official/Legal Authority	10 Other Specified Person(s)
3 Legal Intervention	9 Unknown	3 Other relative	7 Stranger	
4 Gang, Syndicate	8 Other (specify)	4 Unrelated Caregiver	8 Acquaintance	
5 War/civil Insurrection				

Context of Violent Attack (Code from court record) _____

UNIVERSITY OF CAPE TOWN



Department of Community Health

02 April, 1998

To whom it may concern
Faculty of Medicine

Medical School
Anzio Road
Observatory 7925
South Africa
Telephone: (021) 4066 . . .
Fax No: (021) 4066163

Head of Department: Professor J E Myers

RE: MPhil EPIDEMIOLOGY THESIS: DEGREE COURSE 1997 -

This is to advise that the accompanying thesis proposal submitted by Mr R Matzopoulos in part fulfillment of the requirements of the MPhil Epidemiology Degree, has the approval of this Department.

Yours sincerely

Dr R Ehrlich
BBusSc, MBChB, DOH, MFOM, FFCH(SA)
Senior Specialist

RE/cmhc:matzo

RESEARCH PROJECT PROPOSAL FOR THRIIP FUNDING

PLEASE CONSULT CONDITIONS FOR THRIIP GRANTS BEFORE COMPLETING PROPOSAL - CLICK ON "ABOUT THRIIP"

FRD

DTI

ABOUT THRIIP

FOUNDATION FOR RESEARCH DEVELOPMENT

PRESS F1 FOR HELP

AND MORE INFORMATION

PARTICULARS OF APPLICANT			
INITIALS	R	SURNAME	PHILLIPS
FIRST NAME	ROSE	ID NUMBER	7002040167081
RACE	BLACK/		
CITIZENSHIP	SOUTH AFRICAN	OTHER (SPECIFY)	Cur: 2040066
FRD RATING			
HIGHER EDUCATION INSTITUTION (HEI)	MBCHB (UCT)	OTHER	SET1 Ann: 235666
PRESENT POST	SENIOR SCIENTIST		
WHICH ORGANISATION FUNDS YOUR SALARY?	MEDICAL RESEARCH COUNCIL	2.	
FULL-TIME PERMANENT/FULL-TIME TEMPORARY?	PERMANENT		
POSTAL ADDRESS	PO BOX 19070 TYGERBERG 7505		
DEPARTMENT OF/INSTITUTE (E.G. DEPARTMENT OF CHEMISTRY)	HEALTH CONSULTING OFFICE		
POSTAL CODE	7505		
TELEPHONE NUMBER	021 - 838 0495	FAX NUMBER	021 - 838 0410
E-MAIL	RPHILLIP@EAGLE.MRC.AC.ZA		

Black refers to "African", "Indian" or "Coloured".

BACK

FAX TO: _____

FAX NO: (021) 938-0410 PAGE: _____ OF: _____

ATTENTION OF: Adele

FROM: Dawn DATE: 98/06/12

COMPANY: FRD

FAX NO: (012) 481-4977 **Post-It** Notes from JM

CONTINUE

RESEARCH PROJECT PROPOSAL FOR THRIIP FUNDING

PRESS F1 FOR
HELP AND

MORE

INFORMATION

PROJECT INFORMATION	
YEAR FOR WHICH FUNDING IS REQUESTED	1997
HAVE THRIIP FUNDS ALREADY BEEN APPROVED FOR THIS PROJECT FOR ABOVE YEAR? (IF YES, PLEASE INDICATE CURRENT GUN NUMBER)	
NO	
PLEASE INDICATE THE NATURE OF INDUSTRIAL CONTRIBUTION	
FINANCIAL	
TITLE OF PROPOSAL (the title should be descriptive and should be used for the duration of the proposed research plan - maximum 250 characters, including spaces)	
Investigating the role of alcohol as a risk factor for train injury fatalities as part of a collaborative commuter safety project between the MRC and Metrorail	
SHORT TITLE (abbreviated title - maximum of 36 characters, including spaces)	
ROLE OF ALCOHOL IN TRAIN FATALITIES	
INDICATE INTO WHICH ECONOMIC ACTIVITY CLUSTER YOUR PROPOSAL WILL FALL (APPENDIX A)	
TRAN	TRANSPORT INFRASTRUCTURE
INDICATE INTO WHICH BROAD SCIENTIFIC FIELD YOUR PROPOSAL WILL FALL (APPENDIX B)	
HEALTH SCIENCES	
INDICATE INTO WHICH SPECIALISATION FIELD YOUR PROPOSAL WILL FALL (APPENDIX C)	
MAIN 1	MEDI MEDICAL SCIENCES
MAIN 2	BIOM BIOMEDICAL SCIENCES
MAIN 3	STAT STATISTICS & PROBI

MAIN MENU

BACK

CONTINUE

RESEARCH PROJECT PROPOSAL FOR THRIP FUNDING

PRESS F1 FOR
MORE HELP
AND
INFORMATION

EXPECTED DURATION OF PROJECT FROM (YYYYMM/DD)	1997/01/01	TO (YYYYMM/DD)	1998/12/31
NAME OF FRD THEME/PROGRAMME INTO WHICH PROJECT FITS OR FROM WHICH FUNDING IS SOUGHT/APPROVED			
SCENARIO 2			
OBJECTIVES - state the objectives of the project (maximum 500 characters, approx 7 lines)			
<p>The aim of the study is to determine whether alcohol consumption is a risk-factor for unintentional railway-related fatalities. Rail deaths will be collected and sorted into four causal categories: violence, suicides, unintentional and an undetermined injuries. Motor vehicle accident passenger deaths (the comparison group) will be divided into taxi passengers and car passengers. Alcohol usage will be estimated by analysis of blood alcohol levels in each group. The relative risk will be calculated for rail versus motor vehicle fatalities who were exposed to alcohol.</p>			
PROPOSED WORKPLAN (maximum 4 000 characters, approx 2 pages)			
<i>Describe the tasks to be carried out during the whole project; describe the methods to be used, indicate the persons involved, and provide target dates for the start and completion of each task. Include plans to address quality maintenance, corrective action, industry collaboration, networking and cooperation. Indicate expected beneficiaries of work plan.</i>			
<p>The study design will be in the form of a retrospective case-control study of fatalities presenting at Cape Town's two forensic pathology laboratories, ie Salt River and Tygerberg. The rail fatality data will be matched with injury report forms completed by railway personnel in compliance with the Occupational Health and Safety Act of 1995 (OHSA). Fatalities of passengers in motor vehicle accidents will be used as the control group for the study.</p> <p>Cases and controls will have to meet the following selection criteria: 1) deaths due to the late effects of the injury (longer than 6 hours) will be excluded, as blood alcohol measurements will not be available, 2) deaths that were intentionally inflicted or where the cause of death is unclear will be excluded, 3) deaths to minors (as blood alcohol content measurements are not recorded). The sample size required is approximately 100 cases and 100 controls. The data will need to be matched according to age and sex as risk-taking behaviour by young males is a possible confounder. Each death extracted from the mortuary records will be matched, where possible, to a corresponding Metrorail record in order to improve the data quality. The data will be checked and coded for the SAS statistical package and descriptive and comparative statistics will be calculated.</p> <p>Data collection started on 1 June 1997 and will continue until the required number of deaths have been recorded to begin analysis. Surveillance of injury records will continue indefinitely and will be dependent</p>			

on the availability of Metrorail funding. Bi-annual reports on the incidence of rail injuries and fatalities will be presented to Metrorail management as per the contract.

The information will assist Metrorail in understanding the phenomenon of rail commuter injury in Cape Town and applying selective injury interventions to the most appropriate parts of the rail system. The researcher will benefit from the opportunity to apply rigorous epidemiological techniques to the rail injury disease that has afflicted Cape Town.

OBJECTS SUMMARY

Provide expected annual outputs (including human resource and technological, beginning with year for which funds are intended)

Epidemiological research project describing alcohol usage on the Cape Metropolitan rail system and determining the association between alcohol intoxication and rail fatalities.

Metrorail will be provided with an injury and mortality surveillance system including biannual descriptive reports for the duration of the project.

The project will give the research student the opportunity to carry out an epidemiological study and capacity will be built in the field of data collection and management.

2

BACK

MAIN MENU

University of Cape Town

RESEARCH PROJECT PROPOSAL FOR THRIP FUNDING

IS THIS APPLICATION R1:R2 OR R1:R1?	R1 : R2
IF R1:R1, PLEASE SELECT REASON	▽ (multi-company/smmme/students)

BUDGET CONTRIBUTORS FOR YEAR OF APPLICATION

THRIP FUNDING REQUEST	R14 820
THRIP FUNDING ALREADY APPROVED FOR YEAR OF APPLICATION (If applying for additional funding)	
SUB TOTAL FOR THRIP (Budget must be for total THRIP amount)	R14 820
INDUSTRY CONTRIBUTIONS (List industry names with amounts please)	
Cape Metrorail	R29 640
TOTAL INDUSTRY CONTRIBUTION	R29 640
OTHER FRD REQUEST/APPROVED	
OTHER	
TOTAL	R 44 460

BREAKDOWN OF ABOVE BUDGET

	THRIP	INDUSTRY+	TOTAL
SUPPORT PERSONNEL			
RESEARCH ASSISTANT	R 10 000	R20 000	R30 000
TECHNICAL ASSISTANT	R2 000	R3 000	R5 000
TIPTOP (SCHEMES)▽			
SUB TOTAL	R12 000	R23 000	R35 000
RUNNING COSTS			
Printing and materials	R 820	R4 640	R5 460
Travel	R2 000	R2 000	R4 000
SUB TOTAL	R2 820	R6 640	R9 460
EQUIPMENT (SPECIFY)			

IN-KIND CONTRIBUTION			
SUB-TOTAL			
FORWARD ENGAGEMENTS			
≥			
SUB-TOTAL			
OTHER			
≥			
SUB-TOTAL			
	R14 820	R29 840	R44 460

• Industry contribution to components that do not qualify for THRIP support, will be deducted from the total industrial contribution considered for matching THRIP funding.

♦ Local conference attendance will be funded to a maximum of R2 000 per project, provided that a paper is delivered.

▲ Local travel exceeding R5 000, and foreign engagements must be motivated for, taking into account conditions of grant

⊕ TOTALS MUST CORRESPOND

⊗ TOTALS MUST CORRESPOND

SUMMARY OF ESTIMATED FINANCIAL REQUIREMENTS FOR FURTHER YEARS					
YEAR	INDUSTRY	THRIP	FRD	OTHER	TOTAL
1998	R 40 000	R20 000			R60 000
1999	R50 000	R25 000			R75 000
					≥

MOTIVATION FOR LOCAL TRAVEL (IF IT EXCEEDS R5 000)

RESEARCH PROJECT PROPOSAL FOR THRIP FUNDING

INFORMATION ON TEAM MEMBERS

Team members are those receiving funding from this project, and spend at least 20% of their research time on this project (excluding students).

SURNAME	TITLE	INITIALS	ID NO	% TIME SPENT ON THIS PROJECT	RACE (B/W)*	GENDER (F/M)	FRD RATING**	INSTITUTION	DEPT
Philips	Dr	R	7002040167081	30	B	F		MRC	HCO
Bopape	Mr	JL	741130537 9085	20	B	M		MRC	HCO
Van Rensburg	Mr	A	500705 5025083	25	W	M		Metrorail	Risk

*The FRD has embarked on corrective action measures and in its reporting is obliged to reflect its investment in this regard

Black refers to "African", "Indian" or "Coloured".

** If applicable.

PARTICULARS OF STUDENTS (TO BE) INVOLVED IN THIS PROJECT

FRD BURSARS (Y/N)	SURNAME	INITIALS	ID NUMBER	RACE (B/W)*	DEGREE /DIPLOMA REGISTER FOR	GENDER (F/M)
N	Matzopoulos	RG	7108295256089	W	Mphil (Epidemiology)	M
						2

PARTICULARS OF INCUMBENT TO BE RELOCATED

(If an academic/employee then particulars as for "team member"; if a student then particulars as for "Student" above)

Current location/details of incumbent	
Destination details of incumbent	
Particulars of incumbent's supervisor/contact at destination	
Period of relocation	
Degree for which incumbent is registered	
Brief explanation and motivation for incumbent	

NO INCUMBENT