The impact of alcohol-related risk-taking behaviour on younger driver deaths in the Western Cape Province: A retrospective cross-sectional study.

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THESIS ABSTRACT

Drunk driving is a public health threat, endangering the lives of all road users. Younger drivers are inclined to engage in risk-taking behaviour, such as drunk driving with BAC levels exceeding the legal limit. The prevalence of drunk driving in the country has increased among the youth, with children starting to drink alcohol under the age of 13 year in the country. In the Western Cape province, alcohol consumption and risk-taking behaviour were prevalent among school-going children. Younger drivers (15 to 19 years) had the highest driver mortality rates per registered driver, compared to older drivers in the province. Graduated driver license (GDL) programmes provide a supervised learning opportunity for younger drivers to gain driving skills and include a zero-alcohol tolerance restriction. The usefulness of implementing a GDL programme in the country needs to be explored. It is therefore important to understand the impact of alcohol-related risk-taking behaviour among younger drivers.

This retrospective cross-sectional study measured alcohol-attributable crash risk by age and sex, from a sample of 921 driver fatalities from Western Cape mortuary records (2009 to 2011). Poisson regression was used to ascertain whether the mortality risk profile for young drivers was differentially affected by alcohol. Female drivers aged 15 to 24 years with zero or low BAC levels (<0.05 g/100ml) were the reference category. Statistical significance was set at $p<0.05$.

The median age for all driver deaths in the sample was 37 years (IQR 27-49), with 820 males representing 89% of the sample. BAC levels tested among 351 driver fatalities represented 38.1% of the study sample. The median BAC level among all tested driver deaths was zero, with more than half of the sample having BAC levels less than 0.05 g/100ml. The median age for 150 driver deaths with BAC levels ≥ 0.05 g/100ml, was 32.5 years (IQR 26–42). Among 140 male driver deaths testing positive for alcohol, the median BAC level was 0.18 (IQR 0.13-0.23) and among ten female drivers 0.2 g/100ml (0.11-0.21). Male drivers were five times more likely to die from a fatal alcohol-related crash (IRR 5.02; $p< 0.001$; 95% CI: 3.86-6.53). The relative mortality rate was highest among drivers aged 25 to 34 years (IRR 1.54; 95%CI 1.43-1.66; $p<0.001$).

The findings from this study highlights the need for continued and improved BAC surveillance and indicates the need for the broader application of alcohol interventions and development of a GDL programme.

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LIST OF ABBREVIATIONS

AA: Automobile Association

BAC: Blood Alcohol Concentration, the amount of alcohol detectable in a given unit of blood, measured in grams of alcohol per 100 millilitres of blood.

DALY's: Disability adjusted life years

DOH: Department of Health

DUIA: Driving under the influence of alcohol

eNATIS: Electronic National Transport Information System

GDL: Graduated Driver License programme

HIC: High Income Countries

LMIC: Low and Middle Income Countries

MLDA: Minimum legal drinking age

MRC: Medical Research Council

NIMSS: National Injury Mortality Surveillance System

PIMSS: Provincial Injury Mortality Surveillance System

RTI: Road traffic injuries

RTMC: Road Traffic Management Corporation

SA: South Africa

UCT: University of Cape Town

WC: Western Cape province

WHO: World Health Organization

DEFINITIONS OF TERMS

Drunk driving:

Drivers driving with a blood alcohol level above the legal limit, as specified in the National Road Traffic Act, under section 65 (National Road Traffic Act 1996 and Amendment Bill. 2015).

Learner and Driver license (South Africa):

Drivers in South Africa can obtain a learner's license for driving a motor vehicle from the age 17 years and full drivers licensure from the age of 18 years and in the case of a motorcycle from the age of 16 years (National Road Traffic Act 1996).

Heavy episodic drinking:

A form of binge-drinking or harmful alcohol consumption, represented by the consumption of alcohol in the quantities of 60g for males and 40g for females, on a single occasion, over the past seven days (WHO, 2011).

Legal BAC limits for drivers (South Africa):

The current legal BAC limit for drivers driving a motor vehicle in South Africa is set at a BAC level less than 0.05 g/100ml and less than 0.02 g/100ml for professional drivers, as specified in Section 65 of the National Road Traffic Act 1996 (Act No.93 of 1996; Amendment Bill, 2015)

Minimum legal drinking age:

Legal age limit for alcohol purchase and consumption. In South Africa, individuals under the age of 18 years are not legally allowed to purchase or consume alcohol (Liquor Act 59 of 2003).

Road traffic fatality:

Death which occurs within 30 days of the crash (National Road Traffic Act 1996).

Young drivers:

Licensed and unlicensed drivers in the age group 15-20 year of age, operating a motorised vehicle (National Center for Statistics and Analysis, 2017).

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PART A.

RESEARCH PROTOCOL

1. Introduction

1.1 Background

Drunk driving is a public health threat and a major contributor towards the growing burden of preventable death, disability and financial losses from road traffic crashes.

Globally, 26.5% of teenagers in 2016 reported drinking alcohol and were current drinkers (WHO, 2014). Alcohol-related risk-taking behaviour and heavy drinking are precursors of preventable death and injury among the youth aged 15 to 29 years (WHO, 2011). Young adults are prone to drive under the influence of alcohol increasing their risk of a fatal crash, more than older drivers (Zador et al., 2000; Petridou et al., 2000; Hedlund et al., 2003; Juarez et al., 2009; Ramsoomar et al. 2012). When driving under the influence of alcohol younger drivers are more likely to exceed the legal driver BAC limit of 0.05 g/100ml (Zador et al., 2000; Hedlund et al., 2003).

Early initiation of alcohol consumption is a major problem among the youth in South Africa (Reddy et al., 2010). The prevalence of drunk driving among the youth was 25.9% and increased by more than three-fold over the period 2002 to 2008 (Reddy et al., 2002; Reddy et al. 2010). In the Western Cape province increased risk-taking behaviour and alcohol consumption was prevalent among Cape Peninsula school-going children (Flisher et al., 1993). Recent research in 2009 highlighted younger drivers' increased fatal crash risk, with highest driver mortality rates per registered driver among teenage drivers aged 15 to 19 years in the Western Cape province (Chokotho et al., 2012).

The World Report on road traffic injury prevention, emphasised the need for countries to enforce lower BAC limits for younger drivers (WHO, 2009). Graduated driver's license programme (GDL) programmes, include a zero-alcohol tolerance restriction and have proven to be successful in reducing deaths (Hedlund et al., 2003, McKnight et al., 2002; Alderman et al., 2018). The need for a GDL programme in South Africa exists, however further exploration is needed to understand the usefulness of implementing such a programme (Chokotho et al., 2012).

1.2 Study Rationale

The young drinking culture and high younger driver mortality rates per registered driver in the Western Cape province, highlight the need to understand the impact of alcohol on fatal driver crashes. It is important to determine whether younger drivers' increased fatal crash risk were due to their increased propensity to drive intoxicated, or were due to immaturity, inexperience and poor driving skills.

This proposed retrospective cross-sectional study aims to explore alcohol exposure among Western Cape driver fatalities, to answer this important question.

2. Literature review

2.1 Introduction

Driving under the influence of alcohol is a known risk factor for road crash fatalities (Borkenstein et al., 1964; Hurst, et al., 1994; Zador et al., 2000; Peltzer et al., 2011; Taylor et al., 2012). It is well described that young adults engage in risk-taking behaviour such as excessive drinking of alcohol, increasing their chance of a fatal crash (Zador et al., 2000; Petridou et al., 2000; Hedlund et al., 2003; Juarez et al., 2009; Ramsoomar et al. 2012). -

To inform this study on the impact of alcohol-related risk-taking behaviour on younger drivers, this literature review aims to evaluate existing research on a global, national and provincial scale to provide insight into the burden of fatal younger driver crashes, as well as on the risk factors responsible for increasing younger drivers' increased crash risk and the interventions implemented to prevent injury and death.

2.2 Search strategy

An electronic search was performed on Pubmed, Google Scholar and Google Search engine, using keywords and their synonyms. English published and electronically available articles were sought and articles that did not meet the inclusion criteria were excluded.

Studies reporting on the following were reviewed for inclusion:

- Driver deaths of motorised vehicles on roads.
- Driver deaths from road traffic crashes.
- Blood alcohol concentration levels of drivers involved in fatal road crashes.
- Legislation aimed at BAC levels of drivers.
- Concomitant drug use.
- Driver behaviour such as speeding, unrestrained driving.

Exclusion criteria for studies not included in review:

- Drivers of non-motorised vehicles
- Other forms of transportation such as road, air and water transportation
- Pedestrian and passenger deaths.

Table 1. Keywords and search terms

Keyword	Search terms
Drivers	Vehicle driver, motor vehicle driver, driving, road traffic.
Young	Adolescent, teenager, teen, youth, young adult.
Crash	Accident, crash, collision.
Death	Mortality, fatality, fatal.
Drunk	BAC level, intoxicated, alcohol impairment, driving under the influence of alcohol (DUIA), drunk-driving, drink-driving, alcohol-impaired driving.

2.3 Results

2.3.1 Burden of road traffic injuries, globally and in South Africa

Globally road traffic injuries (RTI) are a major public health issue and ranked the leading cause of premature death among the youth aged 5-29 years (WHO, 2015). Rising statistics from RTI (inclusive of all road users) reached 1.35 million fatalities annually, claiming the lives of 3700 road crash victims daily and leaving 50 million survivors suffering from disabilities (WHO, 2018). RTI were globally the eighth leading cause of death among all age groups, substantially more than deaths due to HIV/AIDS, tuberculosis and diarrhoea (WHO, 2015; WHO, 2018). Despite a stable trend in the global RTI mortality rate at 18 deaths per 100 000 population (from 2001 to 2016), reaching the proposed targeted 50% reduction in road traffic deaths by 2020 (per the SDG 3.6 targets) was unlikely (WHO, 2015).

Rapid industrialisation and motorisation in LMICs (low- and middle-income countries) resulted in an increased burden of RTI-related mortality and morbidity (WHO, 2009). RTI mortality rates were highest in LMICs accounting for 93% of global deaths, despite carrying 60% of the global vehicle load (WHO, 2018). The RTI mortality rate in LMICs was more than three times the rate in HICs. LMICs had a RTI mortality rate of 27.5 per 100 000 population and in HICs it was 8.3 per 100 000 population (WHO, 2015). Africa had the highest RTI mortality rate at 26.6 per 100 000 population despite the least number of motorised vehicles

(WHO, 2015). In LMICs no decline in deaths were seen over the period 2013 to 2016 (WHO, 2018).

In South Africa, RTI accounted for 26.7% of all injuries in 2000 (Norman et al., 2007). RTI mortality rates in the country were almost double the global average, with age standardised RTI mortality rates at 39.7 deaths per 100 000 population (59.4 for males and 22.6 for females) (Norman et al., 2007). In 2009 transport-related injuries in the country were responsible for 33.8% of all external causes of deaths, with majority due to road traffic crashes (Matzopoulos et al., 2015). Mid-year estimates from statistics of the Road Traffic Management Corporation (RTMC), over the period 2008 to 2011, indicated that the national number of road traffic injury fatalities (inclusive of all road users) increased to a total count of 13 802 deaths, with the national number of fatal crashes accounting for 10 845 of the deaths (RTMC, 2009; RTMC, 2010). The RTI mortality rate in 2009 accounted for 32.6% of deaths at a rate of 36.1 per 100 000 population (95% CI: 30.9-41.3) (Matzopoulos et al., 2015). South Africa's RTI-related mortality remained high, at 25.9 deaths per 100 00 population, despite a decline over the period 2017 to 2018, (WHO, 2018).

2.3.2 Driver deaths in South Africa and the Western Cape Province

In 2009 driver deaths in South Africa accounted for 22.9% of the road traffic injury death, followed by a further increase to 26% by 2017 (Matzopoulos et al., 2015; State of Road Safety Report, 2017). The mortality rate among South African drivers in 2009 was estimated at 7.0 deaths per 100 000 population (95% CI: 5.7-8.4) and was highest among male drivers at 13.3 deaths per 100 000 population (95% CI: 10.7-16.0) (Matzopoulos et al., 2015). This was higher than the female driver mortality rate at 1.4 driver deaths per 100 000 population (95% CI: 0.9-1.8) (Matzopoulos et al., 2015). Nationally driver fatalities were highest among those in motor vehicles (2099 deaths), followed in a decreasing order by bakkies, motorcycles, minibuses, trucks and lastly buses (RTMC, 2009; RTMC, 2010).

In the Western Cape province, the motor vehicle population increased by 3.2%, from 2008 to 2011, with an increase in learner drivers by 18.7% and fully licensed drivers by 8.7% (RTMC, 2009; RTMC, 2010). Over the same period the RTI mortality rate in the Western Cape Province declined from 28.4 to 24.1 per 100 000 population (RTMC, 2009; RTMC 2010). Driver fatalities in the province, also slightly decreased in numbers, from a count of 464 to 363 driver deaths (RTMC, 2009; RTMC, 2010).

A study performed by Chokotho et al. (2012) investigated driver deaths in the Western Cape Province among different age groups in 2009. This study reported highest driver mortality rates per licensed driver among the age group 15 to19 years, with a steep decline associated with an increase in driver's age (except among those aged 45-49 years), Figure 1 (Chokotho et al., 2012). The study highlighted the importance of using the number of licensed drivers per age category in the denominator to calculate age-specific driver mortality rates or risk ratios (Chokotho et al., 2012). Calculating age-specific driver mortality rates using crude measures such as "per 100 000 population" in the denominator result in an underestimation of young driver deaths, as these measures do not account for differences across populations and inflate the denominator with individuals in the total population of that specific age group, that are not drivers (Bangdiwala et al., 1985; Chokotho et al., 2012).

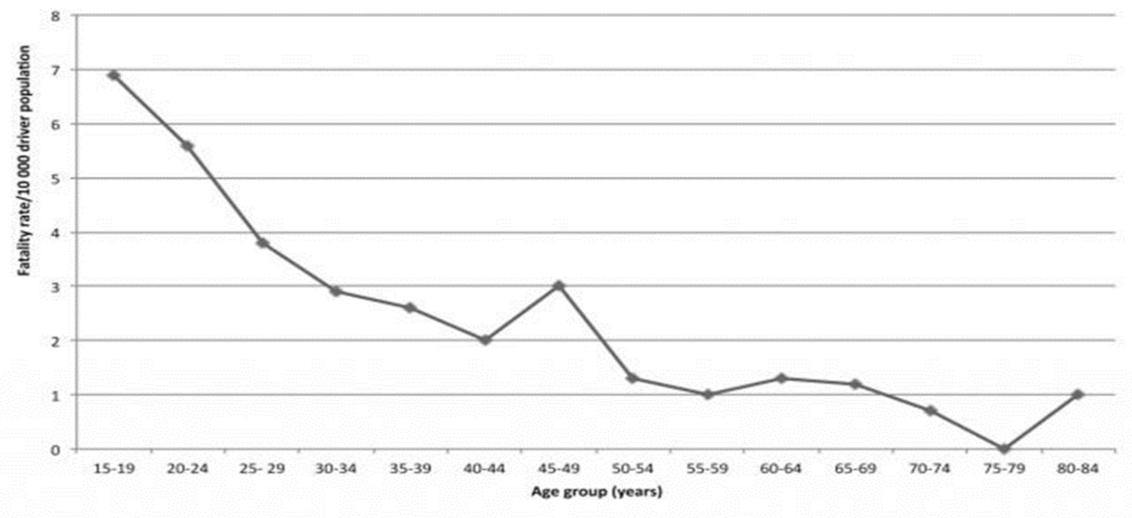

Figure 1. Age-specific driver fatality rate per 10000 registered drivers. (Source: Chokotho et al., (2012)).

2.3.3 Risk factors for road crashes

Risk factors for road traffic crashes are complex. Various risk factors such as poor vehicle and road safety, poor road infrastructure, risk-taking behaviour by road users and ineffective law enforcement, all interact and result in crash-related injury and death (Matzopoulos et al., 2008). Haddon's matrix provides a systematic approach towards crashes and gives insight into risk factors (human, machine or environmental) and their interaction during different phases (pre-crash, crash and post-crash) (Haddon, 1968).

Driving under the influence of alcohol is a known human-related risk factor responsible for increasing a driver's risk of a fatal crash (Borkenstein et al., 1964; Hurst et al., 1994; Taylor et al., 2012; Peltzer et al. 2011; Zador et al. 2000). Alcohol leads to impaired judgment and slowed reaction times of drivers, with a dose-response relationship between a driver's BAC (blood alcohol concentration) level and risk of a fatal crash (Borkenstein et al., 1964; Hurst et al., 1994). BAC levels of 0.04 g/100ml are associated with driver impairment and an increased risk of a fatal crash, any additional increase above this BAC level exponentially increases a driver's risk of death (Borkenstein et al., 1964; Hurst et al., 1994). Taylor et al. (2012) reported that a driver's odds for a fatal crash increase by 1.74 for every 0.02 g/100ml increase in their blood alcohol concentration level (Taylor et al., 2012).

Driving unrestrained in motor vehicles furthermore contribute towards increased road traffic mortality and morbidity (FIA Foundation, 2009). Seat-belt use is life-saving, with a review indicating that it reduces the probability of dying in a fatal crash by 40-50% for both drivers and front seat occupants and by 25% for passengers seated in the back (Elvik, 2004). Seat-belt use is heavily enforced by legislation in HICs, with variable degree among LMICs due to lack of accessibility and law enforcement (FIA Foundation, 2009).

Speeding is another major hazard impacting on road safety globally (FIA Foundation, 2008). Driving at excessive speed results in severe crashes and injuries (Gibson, 1961; Haddon 1973). Speeding drivers have an increased risk of losing control, in addition to a delayed response to unexpected road hazards (Global Road Safety Partnership, 2008).

In addition to alcohol, driving under the influence drugs is another form of risk-taking behaviour. The relationship between drug-related risk-taking behaviour and crash risk is complex, with driving under the influence of both alcohol and drugs increasing a driver's crash risk and the severity of a crash (Peden et al., 2004).

In South Africa, over the period 1999 to 2001, 27% to 55 % of road traffic injured patients admitted to trauma units in Cape Town screened positive for drug use (Parry et al., 2005). Among the sample, alcohol was the main cause responsible for impairment of 28% of the drivers in the trauma units (Parry et al., 2005). In 2008, 37 of 269 drivers (14%) tested positive for driving under the influence of drugs at roadblocks, with 14 drivers (5%) driving under the influence of both alcohol and drugs (Matzopoulos et al., 2013). Drivers with a positive drug screen was 29.8 years and younger than those with a negative screen (however not a significant difference). Among the 37 drivers with a positive drug screen, 9 of the drivers (24%) acknowledge risk-taking behaviour and drove under the influence of drugs on previous rides, with 4 drivers (16%) acknowledging to ever taking drugs before (Matzopoulos et al., 2013).

2.3.4 Burden of alcohol on driver fatalities

Heavy episodic drinking (the consumption of 60g or more of alcohol on a single occasion, over the past seven days), is a form of harmful drinking and associated with increased risk of injuries (WHO, 2011).

Globally harmful alcohol use in 2011 was responsible for 2.5 million annual deaths and ranked the third leading risk factor for injury and disability in LMICs (WHO, 2011). The highest prevalence of heavy drinking was reported in Brazil and South Africa (WHO, 2011). In South Africa, heavy episodic drinking continued to increase over the period of 2005 to 2008 (Peltzer et al., 2011) and was reported to be highest on a global scale among South African males (WHO, 2011).

Accurate estimation of the impact of alcohol on driver fatalities remains a challenge. Globally countries differ on their legal BAC limits for drivers, with BAC levels as low as 0.02 g/100ml in some countries and as high as 0.08 g/100ml in others. In 2009, in the United States 10 839 alcohol-impaired road traffic deaths were recorded with 67% due to drunk driving with BAC levels $\geq$ 0.08 g/100ml (National Center for Statistics and Analysis, 2009). In other HICs, such as Australia, almost a 30% of driver deaths had BAC levels above 0.05 g/100ml, with 38% of drivers in Canada, driving intoxicated with BAC levels above 0.08 g/100ml (Chen et al., 2016).

In South Africa, NIMSS (national injury mortality surveillance system) in 2001 indicated that the prevalence of alcohol-related driver deaths was high at 51.6%, with mean BAC levels 0.17 g/100ml (Sukhai et al. 2004). More recent statistics on alcohol-related driver deaths in the country (over the period 2016 to 2018) estimated the prevalence at 27.1% (after performing extrapolation methodology on the underestimated prevalence of 5.5%) (Govender et al., 2020).

Across different provinces in the country the prevalence of drunk driving was high, with majority of BAC positive drivers intoxicated at levels above the legal limit. In Ga-Rankuwa, over the period 2007 to 2012, 60% of BAC positive drivers drove intoxicated above the legal limit (Du Plessis et al., 2016). In a different study in Pretoria (over a one-year period) 63% of BAC positive drivers drove intoxicated with a mean BAC of 0.17 g/100ml (Ehmke et al., 2014).

2.3.5 Risk factors increasing younger drivers' crash risk

Driving is a task that requires interaction between a driver's higher cognitive function (such as working memory, inhibitory control and attention) and motor skills (Walshe et al., 2017; Banz et al., 2019).

Younger drivers have an increased fatal crash risk due to specific developmental risk factors associated with their age (Haagsma et al., 2016; Alderman et al., 2018). Learning to drive is a skill acquired by drivers at an early age, while still growing and being relatively neurocognitively immature (Banz et al., 2019; Alderman et al., 2018). In addition to these developmental constraints of their age, younger drivers are more likely to engage in risk-taking behaviour such as drinking and driving intoxicated, increasing their risk of a fatal crash more than older drivers (Juarez et al., 2009; Petridou et al., 2000; Hedlund et al., 2003; Zador et al., 2000; Ramsoomar et al. 2012). This was evident in a study by Zador et. al (2000) where the relative risk of a fatal crash doubled for young male drivers (16 to 20 years) when their BAC levels increased by 0.02 g/100ml (Zador et al., 2000). The relative risk of dying in a fatal crash with BAC levels between 0.08 to 0.10 g/100ml, was highest among young male drivers (16 to 20 years) at 51.9 and 11.4 for drivers above the age of 35 years, (Zador et al., 2002).

2.3.6 Burden of alcohol-related, younger driver deaths

Globally, 16% of young adults, aged 15 years and older, engaged in heavy episodic drinking behaviour (WHO, 2014). In the United States in 2015, motor vehicle crashes were the main cause of death among the youth aged 15 to 20 years, with 80% of alcohol-impaired younger drivers driving intoxicated with BAC levels $\geq$ 0.08 g/100ml (National Center for Statistics and Analysis, 2017). Drunk driver deaths accounted for 22% of males and 15% of female driver deaths in the United States (National Center for Statistics and Analysis, 2017).

Alcohol-related risk-taking behaviour increased among the youth in South Africa over the period 2002 to 2008, with children initiating alcohol consumption at a very young age (Reddy et al., 2002; Reddy et al., 2010). The South African Youth Risk Behaviour Survey in 2008 reported 12.1% of children started alcohol intake below the age of 13 years, significantly more males (15.3%) than females (8.6%) (Reddy et al., 2010). The National Youth Risk Behaviour Survey performed in 2008 estimated the lifetime alcohol use (the dose of alcohol consumed during an individual's life) at 49.6% in the country (Reddy et al., 2010). The prevalence of drunk driving in 2002 increased from 7.8% by more than three-fold to 25.9% in 2008, with the prevalence of intoxicated male drivers increasing from 10.2% to 29% and intoxicated female drivers from 5.5% to 18% (Reddy et al., 2002; Reddy et al., 2010).

A study performed among sixteen different Cape Peninsula schools in the Western Cape, reported high levels of binge-drinking and alcohol-related risk-taking behaviour among school going children (Flisher et al., 1993). In this study 63.2% of the teenagers who had driven a vehicle on public roads reported to have been driving without a license, with 8% driving under the influence of alcohol and cannabis. (Flisher et al., 1993).

2.3.7 Alcohol-related interventions, globally and in South Africa

The WHO and World Bank developed road safety strategies and goals for countries across the world, with plans such as the Decade of Action for Road Safety 2011-2020 (United Nations 2017). The Sustainable Development Goals (SDGs) 3.6 target, included in the Decade of Action for Road Safety, aimed to reduce RTI-related deaths with 50% on a global scale by 2020 (United Nations 2017). However, despite the implementation of these plans and strategies over the past decade, RTI-related deaths continued to remain high and especially worse in LMICs (WHO 2015). Subsequently, this initial plan was followed with the New Road Safety Decade of Action, with the target to reduce RTI-related deaths globally with 50% by 2030 (United Nations. 2017). Further to these efforts, the WHO and United Nations implemented strategies to reduce and prevent harmful alcohol use, through the current Global and European Action Plans for the Prevention and Control of Noncommunicable Diseases, globally (WHO 2013; WHO 2016).

Cost effective and successful implementation of road safety measures requires a comprehensive understanding of the distribution of RTI and fatalities among high-risk groups and their associated risk exposure in different areas (Chisholm et al. 2012). A quantile regression analysis performed by Ying et al. (2013) reported the importance to consider both local conditions and specific issues in areas, when implementing regulations aimed at reducing drunk driving mortality rates (Ying et al. 2013). The study indicated that “pre-emptive regulations” encouraging behavioural change towards alcohol consumption were more effective in areas with low mortality rates. “Ex-post regulations” (such as zero tolerance, open container law and legal driver BAC levels) were found to be most effective in areas with high mortality rates.

Graduated driver's license (GDL) programmes have been implemented on an international scale with the aim to reduce younger driver deaths. Different parts of the GDL programme were initially implemented in Australia during 1964 (McKnight et al., 2002). Legislation and implementation of the full GDL programme first occurred in Maryland during 1978 and was followed on a global scale by countries from 1990 onwards (McKnight et al., 2002). HICs have effectively implemented GDL programmes and reported a 20 to 40% reduction in deaths (Hedlund et al., 2003, McKnight et al., 2002; Alderman et al., 2018). Graduated driver licensing programmes provide learners with an opportunity to learn driving skills and experience, under supervision and low-risk conditions. It aims to address risk factors such as immaturity, inexperience and risk-taking behaviour (Petridou et al., 2000; Hedlund et al., 2003). These programmes have a beginner and intermediate phase, with different restrictions and protective measures prior to full licensure (McKnight et al. 2002; Hedlund et al., 2003). A zero BAC limit for beginner and young drivers is one of the restrictions included in the GDL programme. In South Africa the need for implementing a GDL programme exists (Chokotho et al., 2012).

In South Africa various measures to address alcohol-related risk-taking behaviour have been implemented over the past years. The National Road Traffic Act in the country aims to improve road safety and has set the legal BAC limit of drivers at 0.05 g/100ml and at 0.02 g/100ml for professional drivers (National Road Traffic Act 1996; Amendment Bill, 2015). New legislation aimed at lowering driver BAC limits to zero was introduced to Parliament in June 2020 (Meyer 2020). The proposed National Road Traffic Amendment Bill 2020 stipulates that no person may drive a vehicle or be in the driver seat of a motorised vehicle with the vehicle switched on, while on a public road and under the influence of alcohol (with any concentration of alcohol in their blood) (National Road Traffic Amendment Bill 2020).

Despite support from the South African Minister of Transport towards the implementation of the new Bill to lower the legal driver BAC limit to zero, news reports indicated that the Automobile Association of South Africa (AA) resisted the proposed new Bill. The AA emphasised the need to firstly prioritise policing and law enforcement of the current BAC level laws before considering the implementation of the new Bill (Automobile Association of South Africa, 2020). Secondly, the AA suggested setting the legal driver BAC limit at 0.02 g/100ml rather than 0.00 g/100ml, as zero tolerance does not account for alcohol in medications (Automobile Association of South Africa, 2020).

Other measures aimed at controlling alcohol-related risky behaviour among the youth is to raise the minimum legal drinking age (MLDA). In the United States increasing the minimum legal drinking age to 21 years in 1984 resulted in reductions of alcohol-related fatal road crashes among drivers aged 15 to 20 years (Banz et al. 2019). Currently in South Africa the MLDA is 18 years and are being reviewed (Liquor Amendment Bill, 2016). The Liquor Amendment Bill proposes to increase the MLDA to 21 years in the country (Liquor Amendment Bill 2016).

2.4 Conclusion and Research needs

Previous research highlighted the issue of under-reporting, duplication and missing data on road traffic statistics (Chokotho et al., 2013). Accurately captured driver data and road traffic statistics in the national transport registries are vital in providing reliable information on driver deaths.

It is important to understand the impact of alcohol on driver injuries and deaths. In South Africa under-reporting and lack of BAC level driver data are major obstacles contributing to an underestimation of the actual impact of alcohol on road traffic statistics, preventing implementation of appropriate interventions (Govender et al. 2020; Sukhai et al. 2004). Obtaining good quality BAC level data requires effective policing and law enforcement, as well as timely collection of accurate samples from live or deceased bodies. In the case of deceased bodies, timely collection and production of BAC results depend on the efforts of forensic pathologists at mortuaries and at forensic chemistry laboratories.

The high driver mortality rate per registered driver among younger Western Cape drivers and young adults' increased tendency to engage in alcohol-related risk-taking behaviour, highlight the need to understand the impact of alcohol on younger driver deaths. The insight gained on alcohol-related risk-taking behaviour among younger drivers, will aid decision-making on the implementation of appropriate BAC-related interventions and a GDL programme. The proposed study aims to address this knowledge gap by analysis of retrospectively collected alcohol-related mortality data on Western Cape drivers.

3. Aims and objectives

3.1 Aim

The study will explore the alcohol exposure of deceased Western Cape drivers, over the period 2009 to 2011. The study aims to determine whether the higher younger driver mortality rates per registered driver in the age group 15 to 19 years, in the province can be explained by increased alcohol-related risk-taking behaviour. The following objectives will assist in achieving this.

3.2 Objectives

Objective 1:

Review of driver fatality statistics in the Western Cape Province for the period 2009-2011.

> *Hypothesis 1. Western Cape driver fatalities are higher among younger drivers compared to older drivers as per research by Chokotho et al. (2012).*

Objective 2:

To explore alcohol exposure among male and female driver deaths of all ages in the Western Cape province.

> *Hypothesis 2a. Alcohol-related mortality is higher among male compared to female drivers.*
>
> *Hypothesis 2b. Alcohol-related mortality is higher among younger driver compared to older drivers.*

Objective 3:

To determine if alcohol-related risk-taking behaviour among younger, inexperienced drivers explained the higher fatality rates in this age group.

> *Hypothesis 3. The interaction between age and alcohol-related mortality will be highest among younger drivers.*

4. Methodology

4.1 Study design

The study will be a retrospective cross-sectional study and extension of work on previously collected, secondary driver death data obtained from post-mortem investigations from Western Cape mortuaries from 2009-2011.

4.2 Setting

The Western Cape Province covers six districts, City of Cape Town, West Coast, Cape Winelands, Overberg, Garden Route and Central Karoo. Data for this study was collected from 18 mortuaries across the province from these districts.

4.3 Data Sources

In South Africa, it is a medico-legal prerequisite that post-mortem reports are completed by forensic pathologists or medical practitioners. Injury-related data from the Western Cape Province for the study period was captured through the PIMSS (Provincial Injury Mortality Surveillance System) from post-mortem reports, from 18 mortuaries across Western Cape Province (Matzopoulos et al. 2010; Matzopoulos et al. 2011). The PIMSS driver death data for the period 2009 to 2011 will be used as the numerator in calculation of driver fatality rates in the study.

BAC levels for driver deaths will be used as collected from post-mortem folders from mortuaries and government chemical laboratories in Cape Town.

The denominator, registered driver data (from eNATIS for 2009), will be used as representative of the driver population at risk for the study, over the three-year period 2009 to 2011 (eNATIS 2010). Western Cape registered driver population data, stratified by age and gender, will be obtained from the records of the national transport registry, the Electronic National Administration Traffic Information System (eNATIS) for the year 2009 (eNATIS 2010). To match age-standardised data, driver deaths will be grouped into 10-year intervals.

4.4 Population and sampling

The study population will be drivers that died from RTI over the period 2009 to 2011. This study, a quantitative secondary analysis, will be performed on already collected data over the three-year period 2009 to 2011. No additional data will be collected. The data will contain statistics on registered Western Cape drivers and will include post-mortem driver data and associated blood alcohol concentration levels. The data collection form which includes variables for the study is attached in Appendix A.

The study sample will include motor vehicle driver deaths over the period 2009 to 2011. Driver deaths will be categorised by sex into male or female by and age into 10-year age intervals. Driver BAC levels will be categorised into two groupings either zero or low BAC level (< 0.05 g/100ml) or BAC level above the legal limit (≥ 0.05 g/100ml).

The study will exclude driver deaths occurring from other forms of transportation (such as water and air), unlicensed drivers, driver deaths from motorcycles and non-motorised vehicles i.e., bicycles, wheelbarrows etc; driver fatalities outside of Western Cape province; specified pedestrian deaths, specified motor vehicle passenger deaths, driver deaths under the age of 15 years, driver deaths with missing BAC levels and survivors from road traffic crashes. The study will not explore driver's adherence to road safety measures, such as speeding, driving unrestrained, as well as concomitant illicit drug use.

4.5 Variables

For each driver death demographic information such as age and sex, year of death as well as associated BAC level will be collected in the CRF. Counts for each combination of age, sex and year will be tallied with the corresponding population data from eNATIS to calculate age- and sex-specific alcohol-related mortality rates. The variables that will be used in the analysis are summarised in Table 1.

Table 2. Key variables:

Variable	Type	Scale of measurement	Coding
Driver Alcohol-related mortality rate	Outcome	Numerical, continuous data, ratio.	n/a
Driver BAC levels	Predictor	Numerical continuous data binned into categorical, ordinal data.	0: Zero/Low BAC 1: BAC ≥0.05g/100ml
Driver sex	Covariate	Categorical, nominal data.	0: Female 1: Male
Driver age	Covariate	Numerical continuous data, binned into 10-year interval categories as categorical, ordinal data.	10-year age categories: 1: 15-24 years 2: 25-34 years 3: 35-44 years 4: 45-54 years 5: 55-64 years 6: 65+ years

4.6 Statistical analysis

Descriptive analysis will be performed on cleaned data. Missing BAC levels in the PIMSS data set will be matched on "id" with each corresponding driver death and their associated BAC level as recorded by each of the mortuaries across the province.

For purposes of analysis the data will be coded as follows and summarised in Table 1. Sex (male and female); BAC levels (zero or low < 0.05 g/100ml; ≥ 0,05 g/100) and age (10-year categories, starting from 15 years and ending at 65+ years).

The statistical analysis plan for each of the objective is outlined below.

Univariate exploration of continuous and categorical variables will be used to review driver fatality statistics and to describe the demographic profile of intoxicated drivers (Objective 1). Normal distribution will be explored with appropriate use of Box and whisker plots, as well as

Shapiro Wilk test. Descriptive statistics such as the mean and standard deviation will be used for normally distributed data. Non-normally distributed data will be summarised using median and interquartile range. Categorical data will be summarised as count, count%.

Bivariate data exploration will be performed on categorical variables to determine the relationship between the level of alcohol exposure for both age and sex (Objective 2), Chi squared test or Fischer's exact test as appropriate. Level of significance $p < 0.05$.

Multivariate regression analysis using Poisson regression will be used to model the association between sex and age on alcohol-related driver fatalities (Objective 3). Poisson loglinear regression model with robust error variance will be used to estimate alcohol-related incidence rate ratios and confidence intervals among driver deaths adjusting for the impact of age and sex. In the case of over-dispersion, negative binomial regression will be used, followed by a generalised linear model to assess the model fit. Incidence rate ratios and 95% confidence intervals are reported along with statistical significance ($p<0.05$) of the model's findings.

STATA 15.0 software will be used to enter and clean data, for data exploration, statistical tests, modelling and hypothesis testing (Stata Corp 2015). Statistical significance for all analyses will be set at p-value < 0.05. Confidence intervals around rates will be calculated based on the formula [rate ± (1.96rate/√N)].

The dummy tables of the various outputs from the analysis are provided in Tables 3, 4 and 5.

Dummy Table. Table 3. Alcohol-related driver deaths by age and sex in the Western Cape (objectives 1 and 2).

	Total Driver deaths		BAC tested drivers		BAC ≥0.05 g/100ml	
	Male (age) n= **med (IQR)**	**Female (age)** n= **med (IQR)**	**Male** n= **med (IQR)**	**Female** n= **med (IQR)**	**Male** n= **med (IQR)**	**Female** n= **med (IQR)**
Age group (years)	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**
<15						
15-24						
25-34						
35-44						
45-54						
55-64						
65+						
Missing						
Total						

* Age (years); BAC = Blood alcohol concentration; med = median; IQR = interquartile range

Dummy table. Table 4. Poisson regression model adjusted IRR estimates by age, sex and BAC (objective 3).

	2.a.) Univariate model		2.b.) Adjusted model without interaction		2.c.) Adjusted model with interaction	
Deaths	**IRR (95%CI)**	**p-value***	**IRR (95%CI)**	**p-value**	**IRR (95%CI)**	**p-value**
Sex Female (ref) Male						
BAC group Zero/Low BAC≥0.05						
Age group 15-24 25-34 35-44 45-54 55-64 65+						
BAC*Age 15-24 25-34 35-44 45-54 55-64 65+						

Age (years); BAC (g/100ml); *Statistical testing done on comparison of rate ratio for each age category with the reference category; p-value <0.05 denotes statistical significance; †Statistically significant

Dummy table. Table 5. Alcohol-related incidence rate ratios for driver deaths, by age categories, (adjusting for sex) (objective 3).

Age group	Zero/Low BAC		BAC ≥0.05		Age-specific ratio IRR BAC ≥0.05/BAC<0.05
	IRR (95%CI)	p-value*	IRR (95%CI)	p-value*	
15-24 (ref)					
25-34					
35-44					
45-54					
55-64					
65+					

Age (years); BAC (g/100ml); *p-value <0.05 denotes statistical significance; †Statistically significant

5. <u>Ethical considerations</u>

5.1 Research procedure

The study will be a secondary analysis on already collected data. No new data will be collected and no experimentation will be performed on any human participants. Ethical approval for this study was obtained from the University of Cape Town Human Research Ethics Committee (HREC 758/2016) (Appendix B).

5.2 Data management and safety plan

The data management plan will ensure that all data are managed in a secure and safe manner, with no breach of confidentiality. Data for the study will be stored on an electronic platform and will be password protected, only accessible by the principal and contributing, authorised researchers. Only electronic back-ups of data will be saved and no hardcopies will be made of the data or analyses.

5.3 Privacy and confidentiality

Privacy and confidentiality will be maintained throughout the study. All the study participants are deceased and no informed consent will be obtained for this secondary analysis on driver deaths. Confidentiality will be maintained and no personal and identifiable information on any of the study subjects will be captured or used in the analysis. The study will strictly adhere to the agreed upon measures, granted through ethics approval.

5.4 Potential risks and measures minimising risk

The risks associated with this analysis on driver death data are classified as minimal, with no harm or risk to deceased participants. Data will be managed anonymously throughout the study process and analysis and no data will be shared with unauthorised parties.

5.5 Potential benefits

The results from the study will provide essential information on the impact of alcohol-related risk-taking behaviour on driver deaths in the Western Cape Province. This will aid decision making and the development of appropriate interventions to improve road safety for all road users and prevent unnecessary deaths.

5.6 Alternatives to participation and harm to benefit ratio

This study will retrospectively analyse previously collected driver death data, there are no alternatives to participation. The harm to benefit ratio is favourable, with the potential benefits from this study, outweighing any potential risks or harm.

5.7 Declaration of researcher's personal benefit in performing this study

This study will be performed, under the supervision of senior researchers from the University of Cape and the South African Medical Research Council. The study will enable the student researcher the opportunity to complete a Postgraduate Master's degree in Public Health. Obtaining this degree will provide the student researcher with knowledge and experience in the field of research, with future benefit to populations on a small or larger scale.

5.8 End of study

The knowledge gained from this study will be critical towards improving road safety. Results and findings from this study will be made publicly available to all relevant stakeholders, as it will guide decision-making in making roads safer for all users.

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PART B.

"JOURNAL READY" SAMJ ARTICLE

The impact of alcohol-related risk-taking behaviour on younger driver deaths in the Western Cape Province: A retrospective cross-sectional study.

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ABSTRACT

Background

Drunk driving threatens the lives of all road users. Young adults are prone to engage in alcohol-related risk-taking behaviour and more likely to drive intoxicated above the legal limit. The prevalence of drunk driving among younger drivers in South Africa increased more than three-fold over the period 2002 to 2008. In the Western Cape province road traffic statistics in 2009 highlighted a higher fatal crash risk among younger drivers aged 15 to 19 years, compared to older drivers. Graduated driver's license (GDL) programmes include a zero BAC limit for younger drivers and have contributed towards a reduction in deaths. The need for a GDL programme in the South African context exists.

Objectives

This study explored the impact of alcohol-related risk-taking behaviour among Western Cape driver deaths over a three-year period. The study aimed to determine whether younger drivers' (15 to 19 years) increased fatal crash risk was due to their increased propensity to drive intoxicated, above the legal limit, or due to their immaturity and inexperience, represented by their age.

Methods

In this retrospective cross-sectional study, we measured alcohol-attributable crash risk by age and sex, from a sample of 921 driver fatalities, from Western Cape mortuary records (2009 to 2011). Poisson regression was used to ascertain whether the mortality risk profile for young drivers was differentially affected by alcohol. The reference category was female drivers, aged 15 to 24 years and no or low BAC levels. Statistical significance was set at $p < 0.05$.

Results

The median age of 921 driver deaths was 37 years (IQR 27-49) and males accounted for 820 (89%) of the sample. BAC levels tested among 351 driver fatalities, represented 38.1% of the sample. The median BAC level among all driver deaths was zero. The median BAC level among 140 BAC positive male drivers was 0.18 g/100ml (IQR 0.13-0.23) and among 10 female drivers were 0.2 g/100ml (IQR 0.11-0.21). Male drivers were five times more likely to die from a fatal alcohol-related crash (IRR 5.02; $p < 0.001$; 95% CI: 3.86-6.53). The relative mortality rate among intoxicated drivers was highest among drivers aged 25-34 years (IRR 1.54; 95%CI 1.43-1.66; $p<0.001$).

Conclusion

Younger drivers had a differential increased alcohol-related crash risk compared to older drivers, with the effect largest among drivers aged 25-34 years. Alcohol interventions need to be more widely applied, with consideration of a broader GDL approach.

[Word count: 386]

Key words: RTI deaths, road traffic crashes, drunk-driving, driver BAC levels, driver deaths, young drivers.

INTRODUCTION

Drunk driving is a growing, global public health threat and preventable. Globally alcohol-related risk-taking behaviour remains a major risk factor responsible for premature death and disability among the youth aged 15 to 29 years.[1] Heavy episodic drinking, a form of harmful alcohol consumption and a precursor of preventable injuries and deaths, was prevalent among 16% of young adults aged 15 years and older, on a global scale.[2]

Learning to drive is a skill obtained by most beginners at a young age and during a critical developmental period.[3,4] Younger drivers' increased fatal crash risk has been explained by certain specific developmental risk factors such as level of neurocognitive maturity, driving experience and skills, as well as tendency to engage in risk-taking behaviour.[3,4,5,6,7,8]

Driving intoxicated, under the influence of alcohol increases younger drivers' fatal crash risk more than older drivers.[5,6,7,8,9] Research by Zador et al. (2000) reported the relative risk of a fatal crash for male drivers (aged 16 to 20 years) doubled when their BAC levels increased by 0.02 g/100ml and estimated young male drivers' relative risk for a fatal crash at 51.9, with BAC levels between 0.08 to 0.10 g/100ml, compared to 11.4 for drivers above the age of 35 years.[8]

In South Africa 12.1% of children started drinking alcohol before the age of 13 years. The prevalence of drunk driving among the youth over the period 2002 to 2008 increased by three-fold from 7.8% to 25.9%. The prevalence of intoxicated male drivers increased from 10.2% to 29% and intoxicated female drivers from 5.5% to 18% over this period. [10,11] In the Cape Peninsula, the high prevalence of alcohol consumption and drunk driving are a concern among school-going children.[12] Research by Chokotho et al. (2012) highlighted that younger Western Cape drivers (aged 15 to 19 years) had the highest driver mortality rates per registered driver compared to older drivers.[13] An increase in driver's age was associated with a progressive decline in driver mortality rates per registered driver in the province, except among drivers in the age category 45 to 49 years.[13]

The World Report on road traffic injury prevention highlighted the need for countries to enforce lower BAC limits for younger drivers.[14] GDL programmes have successfully been implemented in countries globally and provide learner drivers the opportunity to obtain driving skills and experience, under supervision and low-risk conditions.[4,5,6,7,15] The need for the implementation of a GDL programme in South Africa has been expressed, however the usefulness of implementing such a programme need to be explored.[13]

In response to the high fatal crash risk among younger drivers in the Western Cape Province, this study aimed to explore the impact of alcohol on younger driver deaths in the province, over the period 2009 to 2011. The aim was to understand whether younger drivers' high mortality rates per registered driver were due to their increased propensity to drive intoxicated or due to immaturity, inexperience and poor driving skills.

METHODS

A retrospective, cross-sectional study was performed on secondary driver death data obtained from eighteen Western Cape province mortuaries' post-mortem reports, over the period 2009 to 2011. Alcohol-related driver mortality rates were calculated with driver deaths and associated BAC level data (from forensic pathology services) in the numerator, with the denominator represented by counts of registered drivers in the Western Cape driver population (for the year 2009) obtained from the National Transport Registry.[16,17,18]

The study excluded driver deaths occurring from other forms of transportation (such as water and air), unlicensed drivers, driver deaths from motorcycles and non-motorised vehicles; specified pedestrian deaths, specified passenger deaths, driver deaths under the age of 15 years, driver deaths with missing BAC levels and survivors from road traffic crashes. The study did not explore the indirect impact of alcohol on a driver's adherence to road safety measures, such as speeding, driving unrestrained, as well as concomitant illicit drug use.

Descriptive analysis was performed. Driver alcohol exposure was grouped into two levels, with BAC levels ≥ 0.05 g/100 ml and zero or low BAC levels (BAC < 0.05 g/100 ml). Alcohol-related driver mortality rates for male and female drivers were compared by 10-year interval age-categories, starting from the age of 15 years up to 64 years, with a 65+ year age group for elderly drivers. Poisson regression was performed to determine the effect of sex and age differentially on the number of alcohol-related deaths. A modified Poisson regression model with robust variances was used, controlling for age and sex. The reference category was female drivers aged 15 to 24 years and no or low BAC levels. Statistical significance was set at $p < 0.05$. Comparisons were made with the reference category and between the different age groups. Alcohol-related incidence rate ratios with corresponding confidence intervals were reported, the level of significance set at $p<0.05$. STATA 15.0 software was used to merge and clean data, for data exploration, statistical tests, modelling and hypothesis testing.[19]

Ethics approval for the study was granted by the University of Cape Town's Ethics Committee (HREC 758 / 2016) (Appendix B).

RESULTS

The sample of 921 motor vehicle driver deaths over the three-year period included 850 identified drivers (92%) and 71 unidentified motor vehicle users (8%). 820 male driver deaths contributed to 89% of the sample. The younger age groups had a higher proportion of drivers over the legal limit, evident among male and female drivers. BAC was tested for 351 (38%) of the driver fatalities of the study sample, with 150 driver deaths with BAC levels above the legal limit (fig. 1). BAC results were missing for 570 of all driver deaths. Drivers under the age of 15 years and all drivers with missing BAC levels were excluded from the analysis. Three drivers had both missing sex and BAC levels and were already excluded due to missing BAC levels and were under 15 years.

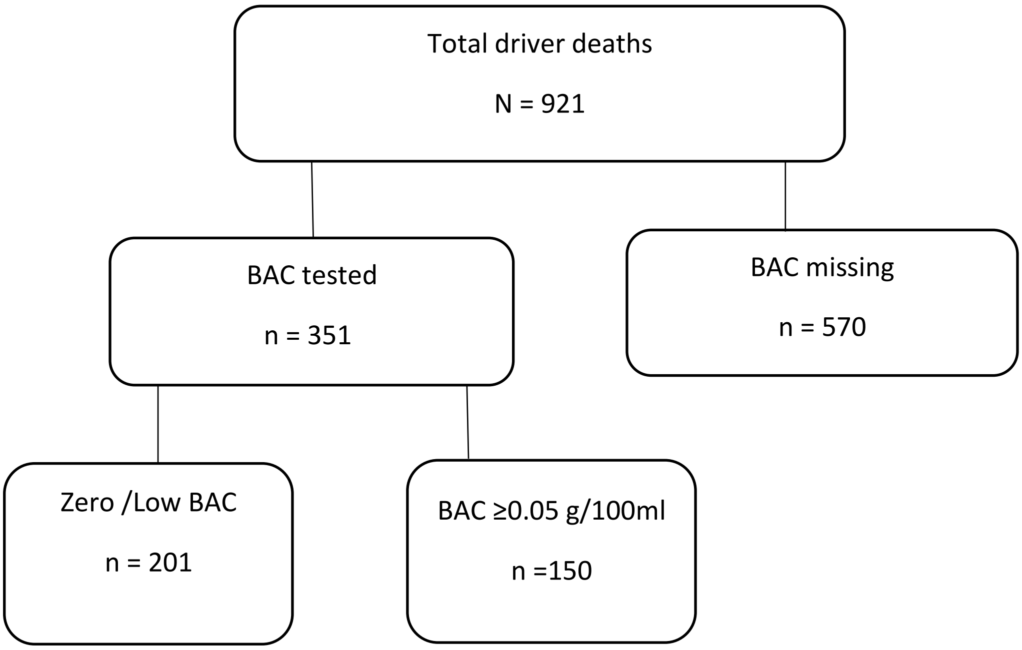

Figure. 1: Flow diagram of data.

Table 1, provides detailed information on driver deaths and BAC levels for males and females by age. This table indicates a higher proportion of male driver deaths, compared to females and a higher proportion of intoxicated driver deaths, among the age group 25 to 34 years, for both males and females.

201 drivers in the sample were classified BAC zero/low, with the median BAC level among all driver deaths zero (Fig1). However, the median BAC level among 140 intoxicated male drivers were 0.18 g/100ml (IQR 0.13-0.23), more than three times the legal limit, compared to females driving intoxicated at BAC levels four times the legal limit, with a median of 0.2 g/100ml (IQR 0.11-0.21).

Table 1. Alcohol-related driver deaths by age and sex in the Western Cape.

	Total Driver deaths		BAC tested drivers		BAC ≥0.05 g/100ml	
	Male (age)	Female (age)	Male	Female	Male	Female
	n=820 med (IQR) 37 (27-49)	n=98 med (IQR) 39 (28-59)	n=310 med (IQR) 0 (0-0.17)	n=41 med (IQR) 0 (0-0.02)	n=140 med (IQR) 0.18 (0.13-0.23)	n=10 med (IQR) 0.2 (0.11-0.21)
Age group (years)	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**
15-24	118 (14.4)	13 (13.3)	47 (15.2)	6 (14.6)	25 (17.9)	2 (20)
25-34	242 (29.5)	22 (22.5)	105 (33.9)	11 (26.8)	57 (40.7)	6 (60)
35-44	170 (20.7)	21 (21.4)	65 (21)	6 (14.6)	34 (24.3)	2 (20)
45-54	157 (19.2)	12 (12.2)	51 (16.5)	7 (17.1)	17 (12.1)	0 (0)
55-64	68 (8.3)	12 (12.2)	19 (6.1)	7 (17.1)	4 (2.9)	0 (0)
65+	62 (7.6)	14 (14.3)	22 (7.1)	4 (9.8)	3 (2.1)	0 (0)
Excluded (< 15 yrs)	1	0	1	0	0	0
Missing	2	4	0	0	0	0
Total	820	98	310	41	140	10

* Age (years); BAC = Blood alcohol concentration; med = median; IQR = interquartile range

Table 2. Poisson regression model adjusted IRR estimates by age, sex and BAC

Deaths	2.a.) Univariate model		2.b.) Adjusted model without interaction		2.c.) Adjusted model with interaction	
	IRR (95%CI)	p-value*	IRR (95%CI)	p-value	IRR (95%CI)	p-value
Sex						
Female (ref)	1.00					
Male	4.97 (3.12-7.90)	<0.001ǂ	5.02 (3.57-7.06)	<0.001ǂ	5.02 (3.86-6.53)	<0.001ǂ
BAC group						
Zero/Low	1.00					
BAC≥0.05	1.06 (0.51-2.21)	0.878	1.06 (0.84-1.33)	0.624	1.48 (1.34-1.64)	<0.001ǂ
Age group						
15-24	1.00		1.00		1.00	
25-34	0.77 (0.30-1.98)	0.583	0.76 (0.54-1.07)	0.112	0.74 (0.70-0.79)	<0.001ǂ
35-44	0.42 (0.16-1.07)	0.069	0.41 (0.30-0.55)	<0.001ǂ	0.45 (0.44-0.46)	<0.001ǂ
45-54	0.40 (0.17-0.98)	0.044ǂ	0.39 (0.28-0.55)	<0.001ǂ	0.59 (0.49-0.70)	<0.001ǂ
55-64	0.24 (0.11-0.53)	<0.001ǂ	0.24 (0.15-0.37)	<0.001ǂ	0.36 (0.23-0.58)	<0.001ǂ
65+	0.19 (0.07-0.53)	0.001ǂ	0.19 (0.09-0.39)	<0.001ǂ	0.37 (0.29-0.46)	<0.001ǂ
BAC*Age						
15-24					1.00	
25-34					1.04 (0.92-1.18)	0.52
35-44					0.83 (0.67-1.03)	0.09
45-54					0.44 (0.33-0.59)	<0.001ǂ
55-64					0.41 (0.25-0.68)	0.001ǂ
65+					0.2 (0.15-0.27)	<0.001ǂ

*Statistical testing done on comparison of rate ratio for each age category with the reference category; p-value <0.05 denotes statistical significance ǂStatistically significant

The univariate models for each of the predictor variables (Table 2 Model a) indicated that male drivers were significantly more likely to die in a fatal crash than female drivers (IRR = 4.97; 95% CI: 3.12-7.90; p < 0.001). In this model, the risk of a fatal crash among intoxicated drivers, with BAC levels ≥ 0.05 g/100ml did not differ from sober drivers, though this was not significant (IRR 1.06; 95%CI 0.51-2.21). Intoxicated young adult drivers aged 25 to 34 years, had the highest risk of a fatal crash in the univariate model, with intoxicated driver deaths decreasing with an increase in age. Intoxicated drivers aged 45 years and older had a significantly lower risk of a fatal crash compared to drivers in the youngest age group (IRR ranges declined from 0.4 down to 0.19).

The adjusted model with all three variables sex, BAC group and age group (Table 2, Model b), as main effects in the model, without the alcohol interaction, had similar results. The risk decreased significantly with an increase in age, above the age of 35 years.

Table 2 Model c, with the interaction between BAC level and age group, indicated that male drivers were still significantly more likely than female drivers to die in a fatal crash (IRR=5.02; 95% CI: 3.86-6.53; p < 0.001) and indicates a significant age and BAC interaction in older age groups from 45 years.

Table 3. Alcohol-related incidence rate ratios for driver deaths, by age categories, (adjusting for sex).

Age group	Zero/Low BAC		BAC ≥0.05		Age-specific ratio IRR BAC ≥0.05/BAC<0.05
	IRR (95%CI)	p-value*	IRR (95%CI)	p-value*	
15-24 (ref)	1.00		1.48 (1.34-1.64)	<0.001†	1.48
25-34	0.74 (0.70-0.79)	<0.001†	1.54 (1.43-1.66)	<0.001†	2.07
35-44	0.45 (0.44-0.46)	<0.001†	1.23 (1.02-1.49)	0.033†	2.71
45-54	0.59 (0.49-0.70)	<0.001†	0.65 (0.49-0.85)	0.002†	1.11
55-64	0.36 (0.23-0.58)	<0.001†	0.61 (0.37-1.00)	0.051	1.68
65+	0.37 (0.29-0.46)	<0.001†	0.30 (0.23-0.39)	<0.001†	0.82

Age (years); BAC (g/100ml); *p-value <0.05 denotes statistical significance; †Statistically significant

Table 3 indicates that among sober drivers, mortality risk decreased as driver's age increased and that the mortality risk was lower than the reference category (15 to 24 years) for all age groups. Among intoxicated drivers, mortality risk was highest among drivers aged 25-34 years (IRR 1.54; 95%CI 1.43-1.66), and then decreased for older age categories. There was a lower risk among drivers 35 years and older, with the IRR range declining from 1.23 to 0.30. When comparing crash risk between intoxicated and sober drivers, within individual age strata, the highest ratio of drunk to sober driver deaths (IRR 2.71) was recorded in the age category 35 to 44 years. A significant reduction in risk was associated with an increase in age, except for drivers aged 55 to 64 years (IRR 0.61; 95%CI 0.37-1.00, p=0.05).

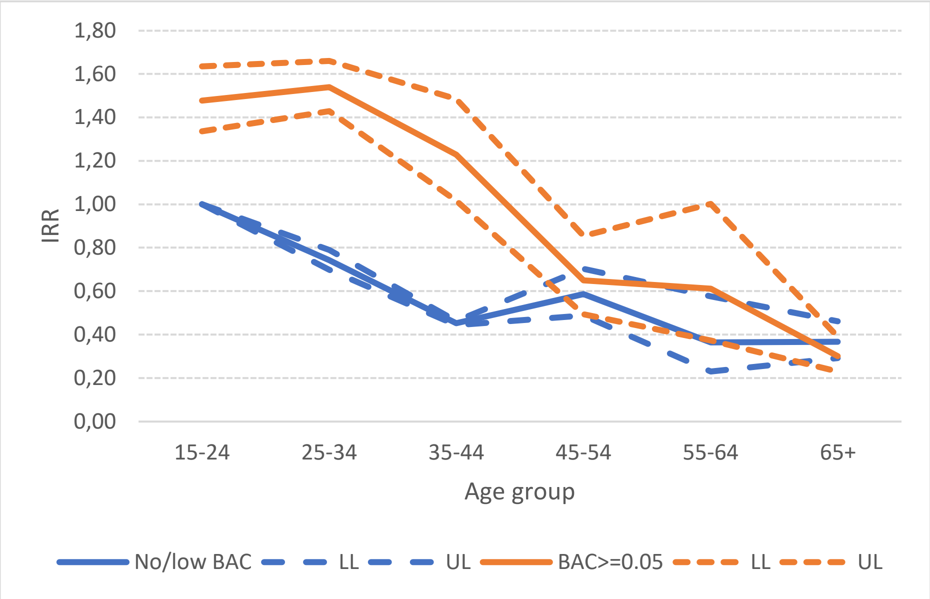

Fig. 2. Alcohol-related driver mortality rate by age group over the period 2009 to 2011 (N=351).

Fig. 2 graphically displays the findings summarised in table 3. The key feature is the decline in the relative mortality rate with an increase in age, indicating how age modifies the effect of alcohol on injury risk. This effect was largest among drivers aged 25 to 34 years. In this figure it is evident that relative mortality risk was highest among younger drivers and intoxicated drivers, for all age groups, up to the age 65+ years. Intoxicated drivers had significantly higher risk from 15 to 44 years and the IRR within age groups peaked in the 35 to 44 year age category.

DISCUSSION

The key feature of the study was to understand if alcohol played a prominent role in the deaths of drivers aged 15 to 19 years. This study indicated the modifying effect of age on alcohol-related injury risk. The impact of age and the alcohol interaction had compelling results for young drivers aged 15 to 24 years, 25 to 34 years and was just significant for those aged 35 to 44 years. These findings proved the hypothesis of a significant alcohol-age interaction, increasing young driver vulnerability when intoxicated, over and above the normal risk from alcohol. However, the highest interaction value was in the age group 25 to 34 years age category and not among drivers 15 to 19 years. Thus, not supporting the hypothesis that alcohol-related driver crash risk was highest among youngest drivers aged 15 to 19 years. Using age as a proxy for inexperienced driving (e.g., just got the license) and driving more (an unmeasured confounder), resulted in the alcohol interaction disappearing among older ages.

In 2001, in South Africa, the mean BAC level of drivers was 0.17 g/100ml, among 51.6% of driver deaths.[20] Nationally, over the period 2016 to 2018 the prevalence was much lower and an underestimation at 5.5% and estimated at 27.1% after extrapolation methodology.[21] Studies done in provinces other than the Western Cape indicated a high prevalence of intoxicated drivers on roads. In Ga-Rankuwa, over a similar period 2007 to 2012, 60% of drivers tested BAC positive, with almost all of them driving intoxicated above the legal limit.[22] A different study from Pretoria (over an one year period) reported that 63% of intoxicated drivers had a mean BAC level in excess of the legal limit at 0.17 g/100ml.[23]

In this study 150 of the 351 BAC tested drivers (42.7%) drove with BAC levels above the legal limit, with the median BAC level (for all BAC tested drivers) being zero. Half of all BAC tested male drivers (45.2%) drove intoxicated above the legal limit. A total of 140 male drivers tested positive for alcohol and drove with a median BAC level of 0.18 g/100ml (IQR 0.05-0.37), three times the legal limit. Female drivers when drunk were more likely to be intoxicated above the legal limit. In this study, ten out of the 41 BAC-tested female drivers drove intoxicated illegally, with a median BAC level four times the legal limit at 0.2 g/100ml. Male drivers were five-fold more likely to die from an alcohol-related crash, though considering the level of intoxication it seemed that female drivers were more likely to be high risk when driving intoxicated.

Male drivers accounted for the largest proportion of the study sample, representing 89% of drivers, with only 98 female drivers, possibly contributing towards a biased result between sexes. This larger numerator for male driver deaths compared to a smaller numerator for female driver deaths, could respectively result in an over- or underestimation of risk between the different sexes.

Other limitations include the accuracy and availability of quality driver population and BAC level data. The accuracy of registered driver data as captured in the national transport registries is vital in providing reliable information on driver deaths. Missing registered driver data will result in a misrepresented, smaller denominator with an overestimation of actual driver mortality rates. This highlights the importance of selecting an appropriate and representative denominator when calculating age-specific driver mortality rates.

Literature has shown that it is most representative to calculate age-specific driver mortality rates by using the actual number of registered drivers at risk (rather than the total population in a specific age category) in the denominator.[13] The use of crude measures, in the denominator for the calculation driver mortality rates, do not account for differences in exposure across populations.[24] This results in an inflated denominator, which includes a section of the population that are not drivers and result in an underestimation of younger driver mortality rates.[13] This study used the annual counts of registered drivers recorded in 2009 in the denominator for the calculation of alcohol-related driver mortality rates (per registered driver) over the three-year period, 2009 to 2011.

The availability of driver BAC level data was a serious limiting factor to this study and lack of driver BAC level data has been highlighted as an obstacle in South Africa.[21] In the study 351 deaths were BAC tested, with missing BAC levels for 570 driver deaths. Possible explanations for this could be that BAC levels are not tested for deaths following the late effects from an injury, such as deaths occurring more than 6 hours after an injury and could also be explained by the fact that some collected BAC samples are not always suitable for interpretation.[25]

This study did not include missing driver BAC level data in the analysis of alcohol-related driver fatality rates. Lack of driver BAC level data raises a red flag not to overlook missing driver BAC level data, as it can be used as an indicator to call for improved measures of policing and law enforcement, which may contribute to more accurate BAC reporting and thus portray a clearer picture of the impact of drunk driving.

CONCLUSION

The research highlighted the relationship between the intoxicated drivers' relative mortality rate and age. Age modified the effect of alcohol on injury risk, with the effect largest among young adult drivers (25 to 34 years) and decreasing with an increase in age. Younger drivers, when driving intoxicated, proved more at risk for a fatal crash than older drivers. Thus, alcohol interventions need to be applied more widely across the driver population, with consideration of a broader GDL approach in future, to address the higher risk among young adult drivers.

Declaration: None

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Author contributions. All authors contributed and participated in the study and critical review of the manuscript.

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Conflicts of interests. None

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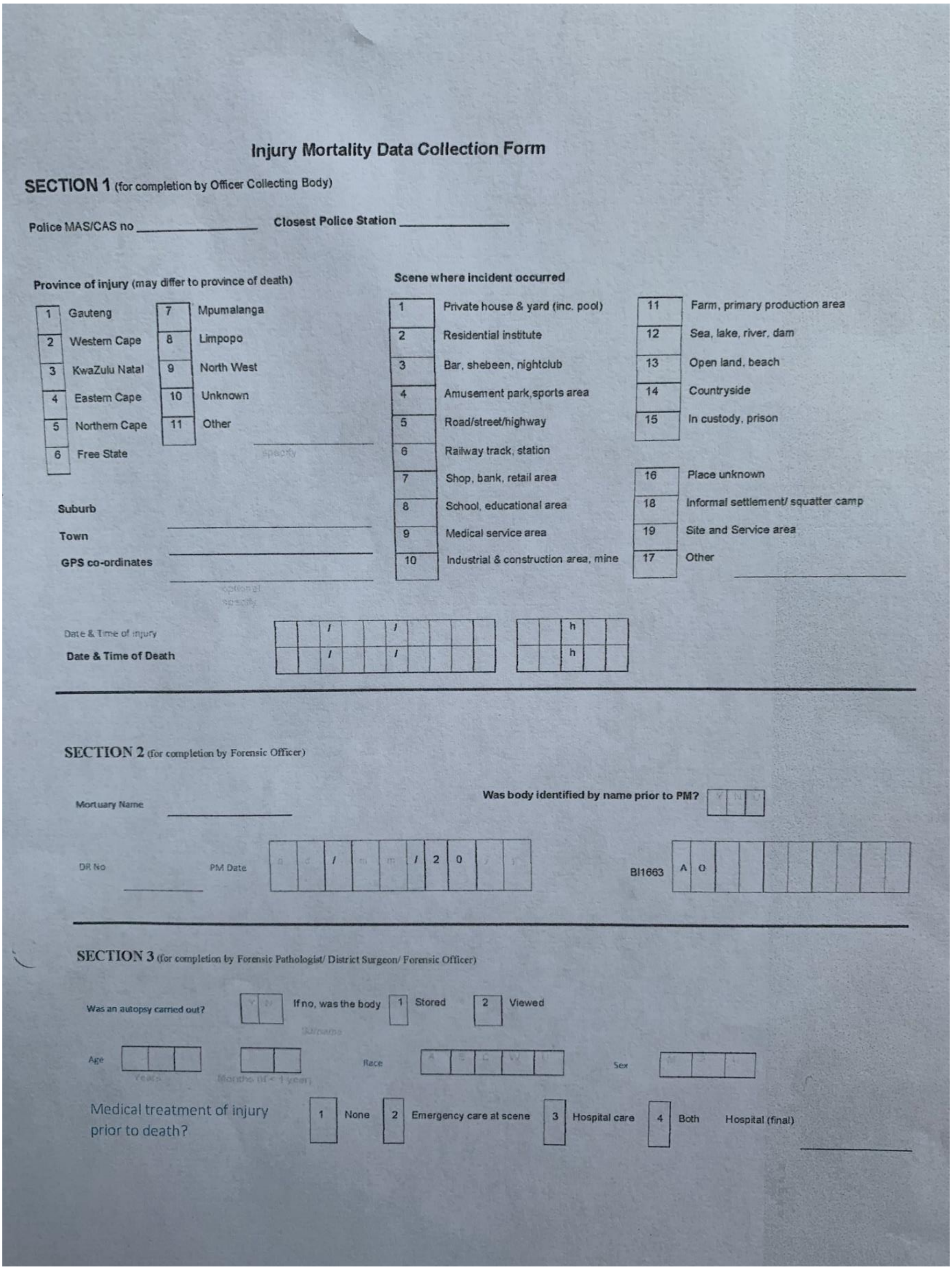
PART C.

APPENDICES

A. Data Collection Form



Injury Mortality Data Collection Form

SECTION 1 (for completion by Officer Collecting Body)

Police MAS/CAS no ____________ Closest Police Station ____________

Province of injury (may differ to province of death)

1 Gauteng
2 Western Cape
3 KwaZulu Natal
4 Eastern Cape
5 Northern Cape
6 Free State
7 Mpumalanga
8 Limpopo
9 North West
10 Unknown
11 Other ____________ specify

Scene where incident occurred

1 Private house & yard (inc. pool)
2 Residential institute
3 Bar, shebeen, nightclub
4 Amusement park,sports area
5 Road/street/highway
6 Railway track, station
7 Shop, bank, retail area
8 School, educational area
9 Medical service area
10 Industrial & construction area, mine
11 Farm, primary production area
12 Sea, lake, river, dam
13 Open land, beach
14 Countryside
15 In custody, prison
16 Place unknown
18 Informal settlement/ squatter camp
19 Site and Service area
17 Other ____________

Suburb ____________

Town ____________

GPS co-ordinates ____________ optional specify

Date & Time of injury _ _ / _ _ / _ _ _ _ _ _ h _ _

Date & Time of Death _ _ / _ _ / _ _ _ _ _ _ h _ _

SECTION 2 (for completion by Forensic Officer)

Mortuary Name ____________

Was body identified by name prior to PM?

DR No ____________ PM Date _ _ / _ _ / 2 0 _ _ BI1663 A O

SECTION 3 (for completion by Forensic Pathologist/ District Surgeon/ Forensic Officer)

Was an autopsy carried out? If no, was the body 1 Stored 2 Viewed

Age ____ Years ____ Months (if < 1 year) Race ____ Sex ____

Medical treatment of injury prior to death? 1 None 2 Emergency care at scene 3 Hospital care 4 Both Hospital (final) ____________

Cause of Death | 1 | Natural | 2 | Non-natural | 3 | Undetermined

Apparent Manner of Death (i.e "Intentionality" if death is non-natural) | 1 | Homicide | 2 | Suicide | 3 | Unintentional | 5 | Undetermined

Circumstances of injury

1	Firearm Discharge	9	Fall/push/jump from height	15	Motor vehicle Pedestrian	21	Medical Procedure
2	Sharp Object	11	Crushing	16	Motor vehicle Passenger	22	Sudden Infant Death
3	Blunt object	13	Drowning, immersion	17	Motor vehicle Driver	23	Abortion/non-viable foetus
4	Asphyxia (hanging, strangulation, suffocation, choking, aspiration)	14	Lightning	18	Motor vehicle Unspecified	24	Abandoned baby
6	Poisoning, ingestion	25	Electrocution	30	Aviation casualty		
7	Poisoning, gassing	26	Explosive blast	31	Motor-cycle	28	Unknown
8	Fire burn/other burn	33	Non-natural disaster	32	Bicycle	29	Other ____________
		34	Natural disaster	35	Railway pedestrian		
				36	Railway passenger		

Special categories

1	Sex-related crime	2	Susp. child abuse	3	Susp. elder abuse	4	Domestic Violence	5	Death in Custody	6	Legal intervention
7	Youth/gang violence	8	Maternal death	9	Mining death	10	Work-related injury	11	Mob violence		ICD 10 code ____________

Special Investigations

Optional

1	Samples for alcohol	2	Samples for toxicology	3	Sample for histology incl. organ retention	4	Samples for suspected rape	5	Samples to identify victim	6	Photography	7	Projectiles

SECTION 4 (for completion by surveillance staff)

Blood Alcohol Level | 0 | . | | | g/100ml   Eye Fluid Alcohol | | | |

B. Letter of approval from UCT Human Research Ethics Committee

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E53-46 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: sumayah.ariefdien@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

06 February 2017

HREC REF: 758/2016

Dr R Matzopoulos
School of Public Health & Family Medicine
Falmouth Building
FHS

Dear Dr Matzopoulos

PROJECT TITLE: TO DETERMINE IF ALCOHOL-RELATED RISK-TAKING BEHAVIOR EXPLAINS THE HIGHER RISK OF ROAD CRASH MORTALITY AMONG YOUNG DRIVERS IN THE WESTERN CAPE, (DURING 2009 -2011) (master's candidate-Dr C Gerber)

Thank you for your email dated 27 January 2017, in reply to our email of 20 October 2016.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 28 FEBRUARY 2018.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

We acknowledge that the student, Dr C Gerber will also be involved in this study.

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator must obtain appropriate institutional approval before the research may occur.

Yours sincerely

Signature Removed

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

HREC 758/2016

UNIVERSITY OF CAPE TOWN

HUMAN RESEARCH ETHICS COMMITTEE 30 MAY 2018

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (FWA00001637; IRB00001938)
This serves as notification of annual approval, including any documentation described below.

☑ Approved	Annual progress report	Approved until/next renewal date	30.5.2019
☐ Not approved	See attached comments		
Signature Chairperson of the HREC	Signature Removed	Date Signed	30/5/2018

Comments to PI from the HREC

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	23 May 2018		
HREC REF Number	758/2016	Current Ethics Approval was granted until	Feb 2018
Protocol title	To determine if alcohol related risk-taking behavior explains the higher risk of road crash mortality, among younger drivers in the Western Cape Province, during 2009-2011		
Protocol number (if applicable)			
Are there any sub-studies linked to this study?	☐ Yes ✔ No		
If yes, could you please provide the HREC Ref's for all sub-studies? Note: A separate FHS016 must be submitted for each sub-study			
Principal Investigator	Richard Matzopoulos		
Department / Office Internal Mail Address	PHFM		

1.1 Does this protocol receive US Federal funding?	☐ Yes	✔ No
1.2 If the study receives US Federal Funding, does the annual report require full committee approval?	☐ Yes	☐ No
1.3 Has sponsorship of this study changed? If yes, please attach a revised summary of the budget.	☐ Yes	☐ No

23 July 2014 Page 1 of 5 FHS016

(Note: Please complete the Closure form (FHS010) if the study is completed within the approval period

HUMAN RESEARCH
ETHICS COMMITTEE
18 -DEC 2020
HEALTH SCIENCES FACULTY
UNIVERSITY OF CAPE TOWN

UNIVERSITY OF CAPE TOWN

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (FWA00001637; IRB00001938)			
This serves as notification of annual approval, including any documentation described below.			
☑ Approved	Annual progress report	Approved until/next renewal date	30.11 21
☐ Not approved	See attached comments		
Signature Chairperson of the HREC/ Designee	Signature Removed	Date Signed	13/12/2020

Note: Please note that incomplete submissions will not be reviewed.
Please email this form and supporting documents (if applicable) in a combined pdf-file to hrec-enquiries@uct.ac.za.
Please clarify your plan for research-related activities during COVID-19 lockdown

Comments to PI from the HREC

Principal Investigator to complete the following:

1. Protocol Information

Date (when submitting this form)	22/11/2020		
HREC REF Number	758/2016	Current Ethics Approval was granted until	30/11/2020
Protocol title2	To determine if alcohol-related risk-taking behaviour explain the higher risk of road crash mortality among younger drivers in the Western Cape Province, during 2009-2011.		
Protocol number (if applicable)			
Are there any sub-studies linked to this study?	☐ Yes X No		
If yes, could you please provide the HREC Ref's for all sub-studies? **Note:** A separate FHS016 must be submitted for each sub-study.			
Principal Investigator	Prof Richard Matzopoulos		

(Note: Please complete the Closure form (FHS010) if the study is completed within the approval period)

C. <u>Author instructions for SAMJ</u>

SAMJ AUTHOR GUIDELINES:

Research

Guideline word limit: 4 000 words

Research articles describe the background, methods, results and conclusions of an original research study. The article should contain the following sections: introduction, methods, results, discussion and conclusion, and should include a structured abstract (see below). The introduction should be concise – no more than three paragraphs – on the background to the research question, and must include references to other relevant published studies that clearly lay out the rationale for conducting the study. Some common reasons for conducting a study are: to fill a gap in the literature, a logical extension of previous work, or to answer an important clinical question. If other papers related to the same study have been published previously, please make sure to refer to them specifically. Describe the study methods in as much detail as possible so that others would be able to replicate the study should they need to. Results should describe the study sample as well as the findings from the study itself, but all interpretation of findings must be kept in the discussion section, which should consider primary outcomes first before any secondary or tertiary findings or post-hoc analyses. The conclusion should briefly summarise the main message of the paper and provide recommendations for further study.

Select figures and tables for your paper carefully and sparingly. Use only those figures that provided added value to the paper, over and above what is written in the text.

Do not replicate data in tables and in text .

Structured abstract

- This should be 250-400 words, with the following recommended headings:
  - **Background:** why the study is being done and how it relates to other published work.
  - **Objectives:** what the study intends to find out
  - **Methods:** must include study design, number of participants, description of the intervention, primary and secondary outcomes, any specific analyses that were done on the data.
  - **Results:** first sentence must be brief population and sample description; outline the results according to the methods described. Primary outcomes must be described first, even if they are not the most significant findings of the study.
  - **Conclusion:** must be supported by the data, include recommendations for further study/actions.
- Please ensure that the structured abstract is complete, accurate and clear and has been approved by all authors.
- Do not include any references in the abstracts.

Main article

All articles are to include the following main sections: Introduction/Background, Methods, Results, Discussion, Conclusions.

The following are additional heading or section options that may appear within these:

- Objectives (within Introduction/Background): a clear statement of the main aim of the study and the major hypothesis tested or research question posed
- Design (within Methods): including factors such as prospective, randomisation, blinding, placebo control, case control, crossover, criterion standards for diagnostic tests, etc.
- Setting (within Methods): level of care, e.g. primary, secondary, number of participating centres.
- Participants (instead of patients or subjects; within Methods): numbers entering and completing the study, sex, age and any other biological, behavioural, social or cultural factors (e.g. smoking status, socioeconomic group, educational attainment, co-existing disease indicators, etc)that may have an impact on the study results. Clearly define how participants were enrolled, and describe selection and exclusion criteria.
- Interventions (within Methods): what, how, when and for how long. Typically for randomised controlled trials, crossover trials, and before and after studies.
- Main outcome measures (within Methods): those as planned in the protocol, and those ultimately measured. Explain differences, if any.

Results

- Start with description of the population and sample. Include key characteristics of comparison groups.
- Main results with (for quantitative studies) 95% confidence intervals and, where appropriate, the exact level of statistical significance and the number need to treat/harm. Whenever possible, state absolute rather than relative risks.
- Do not replicate data in tables and in text.
- If presenting mean and standard deviations, specify this clearly. Our house style is to present this as follows:
- E.g.: The mean (SD) birth weight was 2 500 (1 210) g. Do not use the ± symbol for mean (SD).
- Leave interpretation to the Discussion section. The Results section should just report the findings as per the Methods section.

Discussion

Please ensure that the discussion is concise and follows this overall structure – sub-headings are not needed:

- Statement of principal findings
- Strengths and weaknesses of the study
- Contribution to the body of knowledge
- Strengths and weaknesses in relation to other studies
- The meaning of the study – e.g. what this study means to clinicians and policymakers
- Unanswered questions and recommendations for future research

Conclusions

This may be the only section readers look at, therefore write it carefully. Include primary conclusions and their implications, suggesting areas for further research if appropriate. Do not go beyond the data in the article.

General article format/layout

Accepted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction, which will delay publication.

General:

- Manuscripts must be written in UK English.
- The manuscript must be in Microsoft Word format. Text must be single-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes).
- Please make your article concise, even if it is below the word limit.
- Qualifications, ***full*** affiliation (department, school/faculty, institution, city, country) and contact details of ALL authors must be provided in the manuscript and in the online submission process.
- Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.
- Include sections on Acknowledgements, Conflict of Interest, Author Contributions and Funding sources. If none is applicable, please state 'none'.
- Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dL).
- Litres is denoted with an uppercase L e.g. 'mL' for millilitres).
- Units should be preceded by a space (except for % and ºC), e.g. '40 kg' and '20 cm' but '50%' and '19ºC'.
- Please be sure to insert proper symbols e.g. µ not u for micro, a not a for alpha, b not B for beta, etc.
- Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160.
- Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'
- Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.
- If you wish material to be in a box, simply indicate this in the text. You may use the table format –this is the *only* exception. Please DO NOT use fill, format lines and so on.

SAMJ is a generalist medical journal, therefore for articles covering genetics, it is the responsibility of authors to apply the following:

- Please ensure that all genes are in italics, and proteins/enzymes/hormones are not.

- Ensure that all genes are presented in the correct case e.g. TP53 not Tp53.

**NB: Copyeditors cannot be expected to pick up and correct errors wrt the above, although they will raise queries where concerned.

- Define all genes, proteins and related shorthand terms at first mention, e.g. '188del11' can be glossed as 'an 11 bp deletion at nucleotide 188.'

- Use the latest approved gene or protein symbol as appropriate:

- Human Gene Mapping Workshop (HGMW): genetic notations and symbols
- HUGO Gene Nomenclature Committee: approved gene symbols and nomenclature
- OMIM: Online Mendelian Inheritance in Man (MIM) nomenclature and instructions
- Bennet et al. Standardized human pedigree nomenclature: Update and assessment of the recommendations of the National Society of Genetic Counselors. J Genet Counsel 2008;17:424-433: standard human pedigree nomenclature.

Illustrations/photos/scans

- If illustrations submitted have been published elsewhere, the author(s) should provide consent to republication obtained from the copyright holder.
- Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Fig. 1)'.
- Each figure must have a caption/legend: Fig. 1. Description (any abbreviations in full).
- All images must be of high enough resolution/quality for print.
- All illustrations (graphs, diagrams, charts, etc.) must be in PDF or jpeg form.
- Ensure all graph axes are labelled appropriately, with a heading/description and units (as necessary) indicated. Do not include decimal places if not necessary e.g. 0; 1.0; 2.0; 3.0; 4.0 etc.
- Scans/photos showing a specific feature e.g. *Intermediate magnification micrograph of a low malignant potential (LMP) mucinous ovarian tumour. (H&E stain).* –include an arrow to show the tumour.
- Each image must be attached individually as a 'supplementary file' upon submission (not solely embedded in the accompanying manuscript) and named Fig. 1, Fig. 2, etc.

Tables

- Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged.
- Large tables will generally not be accepted for publication in their entirety. Please consider shortening and using the text to highlight specific important sections, or offer a large table as an addendum to the publication, but available in full on request from the author
- Embed/include each table in the manuscript Word file - do not provide separately as supplementary files.
- Number each table in Arabic numerals (Table 1, Table 2, etc.) and refer to consecutively in the text.
- Tables must be cell-based (i.e. not constructed with text boxes or tabs) and editable.
- Ensure each table has a concise title and column headings, and include units where necessary.
- Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

Do not: Use [Enter] within a row to make 'new rows':

Rather:
Each row of data must have its own proper row:

Do not: use separate columns for *n* and %:

Rather:
Combine into one column, *n* (%):

Do not: have overlapping categories, e.g.:

Rather:
Use <> symbols or numbers that don't overlap:

References

NB: *Only complete, correctly formatted reference lists in Vancouver style will be accepted. Reference lists must be generated manually and not with the use of reference manager software. Endnotes must **not** be used.*

- Authors must verify references from original sources.
- Citations should be inserted in the text as superscript numbers between square brackets, e.g. These regulations are endorsed by the World Health Organization,[2] and others.[3,4-6]
- All references should be listed at the end of the article in numerical order of appearance in the Vancouver style (not alphabetical order).
- Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus.
- Names and initials of all authors should be given; if there are more than six authors, the first three names should be given followed by et al.
- Volume and issue numbers should be given.
- First and last page, in full, should be given e.g.: 1215-1217 **not** 1215-17.
- Wherever possible, references must be accompanied by a digital object identifier (DOI) link). Authors are encouraged to use the DOI lookup service offered by CrossRef:
  - On the Crossref homepage, paste the article title into the 'Metadata search' box.
  - Look for the correct, matching article in the list of results.
  - Click Actions > Cite
  - Alongside 'url =' copy the URL between { }.
  - Provide as follows, e.g.: https://doi.org/10.7196/07294.937.98x

Some examples:

- *Journal references:* Price NC, Jacobs NN, Roberts DA, et al. Importance of asking about glaucoma. Stat Med 1998;289(1):350-355. http://dx.doi.org/10.1000/hgjr.182
- *Book references:* Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975:96-101.
- *Chapter/section in a book:* Weinstein L, Swartz MN. Pathogenic Properties of Invading Microorganisms. In: Sodeman WA, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974:457-472.
- *Internet references:* World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting Healthy Life. Geneva: WHO, 2002. http://www.who.int/whr/2002 (accessed 16 January 2010).
- Legal references

- Government Gazettes:

National Department of Health, South Africa. National Policy for Health Act, 1990 (Act No. 116 of 1990). Free primary health care services. Government Gazette No. 17507:1514. 1996.

In this example, 17507 is the Gazette Number. This is followed by :1514 - this is the notice number in this Gazette.

- Provincial Gazettes:

Gauteng Province, South Africa; Department of Agriculture, Conservation, Environment and Land Affairs. Publication of the Gauteng health care waste management draft regulations. Gauteng Provincial Gazette No. 373:3003, 2003.

- Acts:

South Africa. National Health Act No. 61 of 2003.

- Regulations to an Act:

South Africa. National Health Act of 2003. Regulations: Rendering of clinical forensic medicine services. Government Gazette No. 35099, 2012. (Published under Government Notice R176).

- Bills:

South Africa. Traditional Health Practitioners Bill, No. B66B-2003, 2006.

- Green/white papers:

South Africa. Department of Health Green Paper: National Health Insurance in South Africa. 2011.

- Case law:

Rex v Jopp and Another 1949 (4) SA 11 (N)

Rex v Jopp and Another: Name of the parties concerned

1949: Date of decision (or when the case was heard)

(4): Volume number

SA: SA Law Reports

11: Page or section number

(N): In this case Natal - where the case was heard. Similarly, (C) woud indicate Cape, (G) Gauteng, and so on.

NOTE: no . after the v

- *Other references (e.g. reports) should follow the same format:* Author(s). Title. Publisher place: Publisher name, year; pages.
- Cited manuscripts that have been accepted but not yet published can be included as references followed by '(in press)'.
- Unpublished observations and personal communications in the text must **not** appear in the reference list. The full name of the source person must be provided for personal communications e.g. '...(Prof. Michael Jones, personal communication)'.