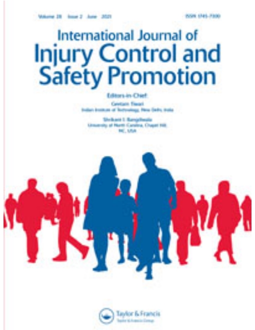

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An analysis on the risk of being injured and killed in road travel injuries in Namibia

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ABSTRACT

Road traffic injuries (RTIs) are a major, global problem. Few studies on RTIs have been conducted in Namibia, despite having one of the highest RTI rates globally. We conducted multinomial logistic regression on national Namibian datasets on RTIs 2012–2014. Being a motorcyclist was associated with the greatest risk of being injured (adjusted Relative Risk Ratio (aRRR) 82.1 (95% CI 47.2–142.9)) or killed (aRRR 202.1 (112.7–362.7)). Risks were also elevated for cyclists (57.3 (23.6–139.5)), pedestrians (15.8 (13.2–18.9), passengers (6.1 (5.2–7.2)), relative to drivers. Among those admitted to hospital, the method of transportation to hospital had the largest association with the risk of dying. To our knowledge this study presents new information on vulnerability of different road users, which can be of use to policymakers to develop specific and targeted interventions to protect the most vulnerable road users.

Abbreviations: DPO: disable people's organisation; EMC: emergency care; HCWs: health care workers; LMICs: lower and middle income countries; MVAF: Motor Vehicle Accident Fund of Namibia; NRSC: National Road Safety Council of Namibia; RTI: road traffic injury; SSA: Sub-Saharan Africa; WHO: World Health Organisation; VKT: vehicle kilometres travelled

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1. Introduction

Road traffic injuries (RTIs) have risen dramatically over the past decade worldwide and now greatly contribute to the global burden of deaths and injuries and represent a major public health challenge (WHO, 2018). RTIs are the leading cause of death for young people aged 15–29 and the eighth leading cause of death globally (WHO, 2015). The RTI death toll from is now estimated to surpass that from diseases such as tuberculosis and malaria, despite the fact that these receive substantially more attention in the global health and international development community (World Bank, 2014).

Sub-Saharan Africa (SSA) is the worst affected region globally, with the highest mortality rate. This was reported to be $26.6/10^5$ population in 2018 (WHO, 2018). However RTIs are neglected in SSA despite the fact that they are largely preventable, and despite the fact that existing public health and transportation knowledge has already significantly reduced the morbidity and mortality rates of RTIs in high-income countries. This is particularly of concern because it is expected that these statistics will continue to worsen in SSA countries due to poor investment in road danger reduction efforts (Chen, 2010). Despite this, few countries have budgeted for RTI prevention and fewer still for RTI-related research in the region (WHO, 2018). Consequently, there has been a relatively limited understanding of RTI patterns, methods of prevention or responses to those injured in RTIs compared with other public health problems (Naci et al., 2009). This is true despite the fact that for over the past decade and a half, the WHO (World Health Organisation) has mandated that all countries carry out more research and data collection on RTIs (WHO, 2004).

Namibia, a SSA country, has one of the worst rates of RTIs globally (WHO, 2018). Even compared with the limited amount of research on RTIs regionally in SSA, there has been very little research on RTIs in Namibia. This is all more the striking because there is now a solid literature on other key public health concerns in Namibia, with significant inroads having been made nationally on the morbidity and mortality associated with infectious diseases. While the Namibian government collects data and issues reports through their main RTI agency, the National Road Safety Council (NRSC), the data collected and analysed in the NRSC reports have several limitations. For example, the data is based only on police reports, so there is significant underreporting of incidents with no police attending (NRSC, 2016). Additional factors related to ongoing inaccurate recording by police officers in Namibia have been highlighted to include deficiencies such as poor record

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keeping, inadequate training of those doing the reporting, and lack of understanding of the importance of accuracy in crash reports (NRSC, 2016). As an illustration, in 2012, only about 2.5% of the crash forms recorded information about seatbelt use of drivers and passengers (NRSC, 2016).

Another major problem in reporting accuracy is that the data collated from the police road crash forms is based on RTI fatalities that occurred within 24 hours of a crash, instead of the 30 day period recommended by the WHO (NRSC, 2015; WHO, 2015). Many who eventually die from RTIs may die in the days or weeks following the collision. Accurate reporting of the delayed fatalities linked to RTIs are further complicated by a reported lack of consistent follow-up on people admitted to hospital with serious RTI-related injuries. Hence the number of fatalities has been underreported and the accuracy of the numbers injured who subsequently become permanently disabled due to RTIs are also obscured (NRSC, 2015). Given all of the above, it is likely that actual RTI deaths and injuries in Namibia are much higher than current estimated in official reports.

Responding to this gap in knowledge, the aim of this study was to analyse national datasets on RTIs to identify patterns for which road users are at greatest risk of being injured or killed. This novel analysis for Namibia used national data sets that are, to the best of our knowledge, the most recent comprehensive ones. Our intention was to provide insight into patterns that will both add to the knowledge on RTIs in Namibia and help generate broader discussion of interventions and insights that might help lower RTIs countrywide.

2. Methods

2.1. Data sources

Electronic access to annual Namibian data sets from 2012 to 2014 on road crashes, deaths and injuries was granted by the Motor Vehicle Accident Fund (MVAF). These datasets were collected and collated by the MVAF based on data from three sources: police records on RTIs; data from calls made to the National Accident Call Centre; and data from claimants involved in RTIs. The MVAF is one of the key agencies involved in road safety in Namibia and is a statutory body funded through a fuel levy organized by the Namibian Ministry of Mines and Energy (Chatukuta, 2019).

The datasets were compiled by the Government in Excel, with three reports for each year including: the Crash Standard Report, the Casualty Report and the Case Hospital Report. The Crash Standard Report contained information for each individual with details of the crash tracked through an assigned serial number, and included the date, day and time the crash occurred; the crash type (such as head on collision, rollover); and the vehicle type involved in the crash. The Casualty Report for each individual contained the crash serial number; the region; age; gender; casualty status (uninjured, injured, or dead); place of death (at scene, in hospital); and method of transportation to hospital. The Casualty Report also contained information on road user types, classified as cyclists, drivers, motorcyclists, passengers, pedestrians, and others. Passengers included any non-driving occupants of any motor vehicles involved in crashes. The Case Hospital Report contained the details of the injury classification; injury category; and the length of stay in hospital.

2.2. Analyses

Initial analysis of data identified the prevalence of injury or death in those involved in a reported crash by gender, age, road user type, and region. The data was analysed using Stata (StataCorp). In order to undertake more comprehensive analysis, the data sets for the Crash Standard and Casualty Reports were combined using a common crash serial number. The Case Hospital Report contained details only for those hospitalized and did not have any connecting variable to the other two reports, so it was analysed separately.

Bivariate and multivariate multinomial logistic regression were then conducted, with ‘uninjured’ as the reference category and ‘injured’ and ‘killed’ as the two outcome variables, given involvement in a reported crash. Potential predictor variables included: day of the week, age, gender, vehicle type, region, and crash type. For the multivariate analysis, all the variables were included. Following this, bivariate and multivariate multinomial logistic regression were repeated for those treated at hospital, with ‘killed’ compared with ‘injured’ as the outcome in order to investigate the effects of the same predictor variables plus the method of transportation to hospital on the likelihood of having died, given transfer to hospital.

The category with the lowest risk was selected as the reference was used, except for gender where this pattern was not used in order to maintain consistency of the tables, as the associations with gender differed by outcome. Crash types were not included in the multivariate regression as there were over 25 different crash types and aggregating categories was not considered appropriate. The results are presented as proportions (%) or Relative Risk Ratios (RRR) and adjusted RRR (aRRR) with 95% confidence intervals (CIs).

3. Results from bivariate and multivariate logistic regression analysis

In the following tables the regions are presented in descending order, in terms of population size, with Khomas at the top as it contains the largest population.

Table 1 presents the descriptions of individuals included in the datasets. Both the bivariate and multivariate analyses conducted showed that the road user type had the highest relative risk ratios for being injured or killed (Table 2). Being a motorcyclist was associated with the greatest risk of being injured (aRRR 82.1 (95% CI 47.2–142.9)) or killed (aRRR 202.1 (112.7–362.7)) in the reported crashes. Risks were also elevated for cyclists, pedestrians, passengers, and other road users, relative to drivers. The other associations were weaker. In multivariate analysis, women were more likely than men to be injured but no more likely to be killed. Children (0–17 y) were significantly less likely to be injured than

Table 1. Descriptions of individuals included in the analyses.

	Crash, not injured N (%)	Injured N (%)	Killed N (%)	Total N (%)
Road user group				
Driver	6,578 (59)	4,196 (37)	438 (4)	11,212 (100)
Motorcyclist	1 (3)	32 (82)	6 (15)	39 (100)
Cyclist	17 (5)	317 (86)	35 (9)	369 (100)
Passenger	2,599 (18)	10,786 (76)	856 (6)	14,241 (100)
Pedestrian	101 (3)	2,795 (80)	593 (17)	3,489 (100)
Other	15 (27)	39 (71)	1 (2)	55 (100)
Vehicle type				
Bus	792 (30)	1,744 (66)	112 (4)	2,648 (100)
Motorcycles	59 (22)	190 (71)	19 (7)	268 (100)
Sedans	4,434 (35)	7,669 (61)	689 (5)	12,792 (100)
SUVs	431 (34)	760 (60)	73 (6)	1,264 (100)
Pick-ups	3,809 (32)	7,522 (62)	772 (6)	12,103 (100)
Vans	79 (32)	142 (59)	21 (9)	242 (100)
Trucks	733 (33)	1,306 (58)	194 (9)	2,233 (100)
Gender				
Male	7,928 (36)	12,855 (58)	1,432 (6)	22,215 (100)
Female	1,673 (18)	7,145 (76)	531 (6)	9,349 (100)
Age group				
0–17	338 (13)	2,022 (77)	257 (10)	2,617 (100)
18–29	1,962 (23)	5,883 (70)	540 (7)	8,385 (100)
30–39	2,521 (33)	4,669 (61)	460 (6)	7,650 (100)
40–49	1,443 (33)	2,625 (60)	276 (7)	4,344 (100)
50–59	752 (32)	1,425 (60)	196 (8)	2,373 (100)
60–69	298 (30)	584 (60)	97 (10)	979 (100)
70–79	79 (23)	222 (64)	47 (13)	348 (100)
80+	20 (19)	59 (56)	26 (25)	105 (100)
Region				
Khomas	2,926 (35)	5,195 (62)	228 (3)	8,349 (100)
Ohangwena	423 (31)	826 (61)	116 (8)	1,365 (100)
Omusati	307 (27)	725 (64)	100 (9)	1,132 (100)
Kavango	259 (22)	723 (63)	168 (15)	1,150 (100)
Oshikoto	711 (30)	1,476 (62)	179 (8)	2,366 (100)
Oshana	684 (30)	1,466 (64)	147 (6)	2,297 (100)
Erongo	977 (30)	2,085 (64)	175 (6)	3,237 (100)
Otjozondjupa	1,005 (33)	1,831 (59)	250 (8)	3,086 (100)
Caprivi	179 (32)	309 (56)	66 (12)	554 (100)
Kunene	300 (32)	552 (59)	81 (9)	933 (100)
Hardap	540 (33)	994 (60)	116 (7)	1,650 (100)
Karas	361 (32)	680 (61)	80 (7)	1,121 (100)
Omaheke	269 (29)	604 (64)	69 (7)	942 (100)
Day of week				
Monday	1,176 (32)	,243 (62)	209 (6)	3,628 (100)
Tuesday	1,068 (33)	2,016 (61)	209 (6)	3,293 (100)
Wednesday	1,010 (33)	1,816 (60)	205 (7)	3,031 (100)
Thursday	1,115 (31)	2,270 (63)	203 (6)	3,588 (100)
Friday	1,560 (32)	2,961 (62)	283 (6)	4,804 (100)
Saturday	1,657 (31)	3,327 (62)	376 (7)	5,360 (100)
Sunday	1,356 (30)	2,835 (63)	290 (7)	4,481 (100)
Method of transportation to hospital once injured in crash				
Private vehicle	N/A	2,177	N/A	
State ambulance	N/A	5,201	N/A	
Private ambulance	N/A	5,803	N/A	
Police	N/A	1,017	N/A	

adults aged 30–39 y (aRRR 0.8 (0.7–0.9)), while adults aged 50+ were more likely to die. Each vehicle type was associated with a greater risk of causing death than bus incidents. Collisions occurring at the weekend were more likely to be associated with fatalities. Collisions in regions outside Khomas were more likely to be associated with fatalities.

Among those admitted to hospital with an injury, the method of transportation to hospital is influencing the risk of dying. Specifically, being transported to the hospital by the police was associated with greatest risk of dying (aRRR 93.0 (70.0–123.5)) compared with a private ambulance. Transport in a state ambulance or by private car was associated with much smaller increased risks. Among those admitted to hospital with a RTI, the 80+ age group had the highest risk of dying compared with other age groups, while females had a lower risk of dying compared to males. We also identified a raised RRR for many regions for death in hospital but significantly lower aRRR for the same regions in multivariate regression. The day of the week was not associated with outcome. These results are presented in Table 3.

Table 4 shows the distribution of road crash types and Table 5 the results of multinomial regression analysis on the risk of being injured or killed, by crash type. The crash types are ordered in descending order with reference to the number of crashes. Chain collisions were chosen as the reference group because they showed the lowest risk of injury. Compared with other crash types, hit and run crashes were associated with greatest risk of injury and death.

Table 2. Relative risk ratios from bivariate and multivariate multinomial regression.

	Bivariate regression[a]		Multivariate regression[a,b]	
	Injured RRR (95% CI)	Killed RRR (95% CI)	Injured aRRR (95% CIs	Killed aRRR (95% CI)
Road user group				
Driver (reference)	1	1	1	1
Motorcyclist	**66.0 (44.0–99.1)**	**132.7 (86.1–204.4)**	**82.1 (47.2–142.9)**	**202.1 (112.7–362.7)**
Cyclist	**28.0 (17.4–45.1)**	**29.1 (16.4–51.6)**	**53.8 (23.9–121.4)**	**57.3 (23.6–139.5)**
Pedestrian	**8.8 (8.1–9.5)**	**10.1 (8.9–11.6)**	**12.6 (11.2–14.2)**	**15.8 (13.2–18.9)**
Passenger	**6.3 (5.9–6.7)**	**4.9 (4.3–5.6)**	**7.3 (6.6–8.1)**	**6.1 (5.2–7.2)**
Other	**10.1 (5.2–19.7)**	**11.6 (4.6–29.6)**	**10.1 (4.0–25.8)**	**13.6 (4.1–44.7)**
Vehicle type				
Bus (reference)	1	1	1	1
Motorcycles	**1.5 (1.1–2.0)**	**2.3 (1.3–4.0)**	**2.8 (1.8–4.4)**	**4.6 (2.2–9.5)**
Sedans	**0.8 (0.7–0.9)**	1.1 (0.9–1.4)	1.1 (0.9–1.2)	**1.5 (1.2–2.0)**
SUVs	**0.8 (0.7–0.9)**	1.2 (0.9–1.7)	1.2 (0.9–1.5)	**1.6 (1.1–2.3)**
Pick-ups	0.9 (0.8–1.0)	**1.4 (1.2–1.8)**	1.2 (1.0–1.4)	**1.6 (1.3–2.1)**
Vans	0.8 (0.6–1.1)	**1.9 (1.1–3.2)**	0.8 (0.5–1.2)	1.8 (1.0–3.5)
Trucks	**0.8 (0.7–0.9)**	**1.9 (1.5–2.5)**	1.1 (0.9–1.4)	**2.7 (2.0–3.7)**
Gender				
Male (reference)	1	1	1	**1**
Female	**2.6 (2.5–2.8)**	**1.8 (1.6–2.0)**	**1.5 (1.4–1.7)**	1.0 (0.9–1.2)
Age group				
0–17	**3.2 (2.9–3.7)**	**4.2 (3.4–5.0)**	**0.8 (0.7–0.9)**	1.0 (0.8–1.3)
18–29	**1.6 (1.5–1.7)**	**1.5 (1.3–1.7)**	1.1 (1.0–1.2)	1.1 (1.0–1.4)
30–39 (reference)	1	1	1	1
40–49	1.0 (0.9–1.1)	1.0 (0.9–1.2)	1.0 (0.9–1.1)	1.1 (0.9–1.3)
50–59	1.1 (0.9–1.1)	**1.4 (1.2–1.7)**	1.1 (0.9–1.3)	**1.5 (1.2–1.8)**
60–69	1.1 (0.9–1.2)	**1.8 (1.4–2.3)**	1.0 (0.8–1.2)	**1.7 (1.3–2.3)**
70–79	**1.5 (1.2–2.0)**	**3.3 (2.2–4.7)**	1.1 (0.8–1.6)	**2.1 (1.3–3.3)**
80+	**1.6 (1.0–2.7)**	**7.1 (3.9–12.9)**	0.8 (0.4–1.6)	**3.6 (1.6–8.0)**
Region				
Khomas (Reference)	1	1	1	1
Ohangwena	1.1 (1.0–1.2)	**3.5 (2.8–4.5)**	1.2 (1.0–1.4)	**4.4 (3.3–5.9)**
Omusati	**1.3 (1.2–1.5)**	**4.2 (3.2–5.4)**	**1.4 (1.1–1.7)**	**6.0 (4.4–8.3)**
Kavango	**1.6 (1.4–1.8)**	**8.3 (6.6–10.5)**	1.7 (1.4–2.1)	9.4 (6.0–12.8)
Oshikoto	**1.2 (1.1–1.3)**	**3.2 (2.6–4.0)**	1.1 (0.9–1.2)	**3.7 (2.9–4.8)**
Oshana	**1.2 (1.1–1.3)**	**2.8 (2.2–3.4)**	**1.3 (1.2–1.6)**	**3.3 (2.6–4.2)**
Erongo	**1.2 (1.1–1.3)**	**2.3 (1.9–2.8)**	**1.4 (1.3–1.6)**	**3.2 (2.6–4.1)**
Otjozondjupa	1.0 (0.9–1.1)	**3.2 (2.6–3.9)**	**1.3 (1.1–1.4)**	**4.7 (3.7–5.9)**
Caprivi	1.0 (0.8–1.2)	**4.7 (3.5–6.5)**	**1.3 (0.9–1.7)**	**6.8 (4.5–10.2)**
Kunene	1.0 (0.9–1.2)	**3.5 (2.6–4.6)**	**1.4 (1.1–1.8)**	**6.0 (4.2–8.6)**
Hardap	1.0 (0.9–1.2)	**2.8 (2.2–3.5)**	**1.4 (1.2–1.7)**	**4.4 (3.3–5.8)**
Karas	1.1 (0.9–1.2)	**2.8 (2.1–3.8)**	**1.5 (1.2–1.8)**	**4.0 (2.8–5.5)**
Omaheke	**1.3 (1.1–1.5)**	**3.3 (2.4–4.4)**	**1.3 (1.1–1.7)**	**4.2 (2.9–6.0)**
Day of week				
Monday (reference)	1	1	1	1
Tuesday	1.0 (0.9–1.1)	1.1 (0.9–1.4)	1.0 (0.8–1.1)	1.1 (0.8–1.4)
Wednesday	0.9 (0.8–1.0)	1.1 (0.9–1.4)	1.0 (0.8–1.1)	1.2 (0.9–1.6)
Thursday	1.1 (1.0–1.2)	1.0 (0.8–1.3)	1.0 (0.9–1.2)	1.0 (0.8–1.2)
Friday	1.0 (0.9–1.1)	1.0 (0.9–1.2)	1.0 (0.9–1.2)	1.1 (0.9–1.4)
Saturday	1.1 (1.0–1.2)	**1.3 (1.1–1.5)**	1.1 (1.0–1.3)	**1.6 (1.2–1.9)**
Sunday	1.1 (1.0–1.2)	1.2 (1.0–1.5)	1.2 (1.0–1.4)	**1.4 (1.1–1.8)**

Results significant at the 5% level are shown in bold.
[a]The outcome reference category for the logistic regression was 'uninjured'.
[b]The relative risk ratios are mutually adjusted for all the other variables presented in the table.

4. Discussion

The results of multivariate regression analysis show that motorcyclists had the highest risk of death and injury. We found a very high aRRR for injuries and deaths for motorcyclists… Although lower than motorcyclists, the risk of death and injury for pedestrians, cyclists, and passengers were also all significantly much higher than that of drivers. All of these results undoubtedly confirm the vulnerability of these road user groups compared with motorists and are in line with statistics published by the WHO (2015), who indicated that in LMICs these groups have much greater vulnerability than car drivers. Our results are also in line with findings from other countries in Africa (Chen, 2010; WHO, 2018).

It can be expected, that the higher risk of death for motorcyclists is likely to be due to the lack of wearing helmets which has been highlighted to be a considerable problem in Namibia (WHO, 2015). This is because injuries to the head and neck are the main cause of severe injury, disability and death among users of motorcycles, and the importance of helmets is well documented in that they help to reduce the risk of serious head and brain injuries by reducing the impact of a force or collision to the head (Otte, 1998; WHO, 2018) and they are the most important piece of motorcycle protective equipment (Hofmann et al., 2018).

Pedestrians are prone to more serious injury and death when involved in crashes because they lack the speed and mobility to get out of the way of oncoming motor vehicles

Table 3. Relative risk ratios from bivariate and multivariate logistic regression for 'killed' compared with 'injured'.

	Bivariate regression[a] RRR (95% CI)	Multivariate regression[a,b] aRRR (95% CI)
Road user group		
Driver	1	1
Motorcyclist	**2.0 (1.7–2.4)**	**2.7 (2.0–3.6)**
Cyclist	1.0 (0.7–1.5)	1.0 (0.5–1.9)
Pedestrian	1.2 (1.0–1.3)	**1.4 (1.1–1.8)**
Passenger	**0.8 (0.7–0.9)**	0.8 (0.7–1.0)
Other	1.1 (0.5–2.4)	1.8 (0.6–5.6)
Vehicle type		
Bus (reference)	1	1
Motorcycles	1.5 (0.9–2.6)	2.2 (0.9–5.3)
Sedans	**1.4 (1.1–1.7)**	1.3 (0.9–1.8)
SUVs	**1.5 (1.1–2.1)**	1.1 (0.7–1.8)
Pick-ups	**1.6 (1.3–2.0)**	1.2 (0.9–1.7)
Vans	**2.3 (1.4–3.8)**	1.6 (0.7–3.6)
Trucks	**2.3 (1.8–3.0)**	**2.2 (1.4–3.2)**
Gender		
Male (reference)	1	**1**
Female	**0.7 (0.6–0.8)**	**0.8 (0.6–0.9)**
Age group		
0–17	**1.3 (1.1–1.5)**	**1.5 (1.1–1.9)**
18–29	0.9 (0.8–1.1)	1.1 (0.9–1.3)
30–39 (reference)	1	1
40–49	1.1 (0.9–1.2)	1.2 (0.9–1.5)
50–59	**1.4 (1.2–1.7)**	**1.6 (1.2–2.1)**
60–69	**1.7 (1.3–2.1)**	**1.8 (1.3–2.7)**
70–79	**2.1 (1.5–3.0)**	**2.1 (1.2–3.5)**
80+	**4.5 (2.7–7.1)**	**6.4 (2.6–15.5)**
Region		
Khomas (Reference)	1	1
Ohangwena	**3.2 (2.5–4.0)**	**0.4 (0.3–0.6)**
Omusati	**3.1 (2.5–4.0)**	**0.5 (0.4–0.8)**
Kavango	**5.3 (4.3–6.6)**	1.0 (0.6–1.5)
Oshikoto	**2.8 (2.3–3.4)**	0.8 (0.6–1.1)
Oshana	**2.3 (1.8–2.8)**	**0.5 (0.4–0.7)**
Erongo	**1.9 (1.6–2.3)**	1.3 (1.0–1.8)
Otjozondjupa	**3.1 (2.6–3.8)**	1.4 (1.0–1.9)
Caprivi	**4.9 (3.6–6.5)**	**0.6 (0.3–0.9)**
Kunene	**3.3 (2.6–4.4)**	**0.6 (0.4–0.9)**
Hardap	**2.7 (2.1–3.4)**	1.0 (0.7–1.5)
Karas	**2.7 (2.1–3.5)**	1.0 (0.6–1.5)
Omaheke	**2.6 (2.0–3.5)**	0.9 (0.6–1.3)
Day of week		
Monday	1	1
Tuesday	1.1 (0.9–1.4)	1.1 (0.8–1.4)
Wednesday	1.2 (1.0–1.5)	1.1 (0.8–1.5)
Thursday	1.0 (0.8–1.2)	0.9 (0.6–1.2)
Friday	1.0 (0.9–1.2)	1.1 (0.9–1.5)
Saturday	1.2 (1.0–1.4)	1.2 (0.9–1.5)
Sunday	1.1 (0.9–1.3)	1.1 (0.8–1.4)
Method of transportation to hospital once injured in crash		
Private ambulance	1	1
Police	**53.5 (43.7–65.5)**	**93.0 (70.0–123.5)**
State Ambulance	**2.3 (1.8–2.9)**	**3.0 (2.2–4.0)**
Private vehicle	**2.4 (1.8–3.1)**	**3.5 (2.5–4.9)**

Results significant at the 5% level are shown in bold.
[a]The outcome reference category for the logistic regression was 'injured, but not fatally, and taken to hospital'.
[b]The relative risk ratios are mutually adjusted for all the other variables presented in the table.

Table 4. Distribution of road crash types in Namibia, 2012–2014.

Type of crash	N	% (95%CI)
Collision with pedestrians	2,767	24.5 (23.7–25.3)
Roll-overs	2,681	23.8 (23.0–24.5)
Head Side collision	957	8.5 (8.0–9.0)
Head rear collision	690	6.1 (5.7–6.6)
Hit and run	538	4.8 (4.4–5.2)
Head-on collision	497	4.4 (4.0–4.8)
Collison with fixed object	362	3.2 (2.9–3.5)
Lost control	359	3.2 (2.9–3.5)
Collision with cyclist	346	3.1 (2.8–3.4)
Side wipe collisions	296	2.6 (2.3–2.9)
Fell from moving vehicle	250	2.2 (1.9–2.7)
Collision with animal (domestic)	245	2.2 (1.9–2.5)
Chain collision	214	1.9 (1.7–2.2)
Collision with wild animal	213	1.9 (1.7–2.2)
Burst tyre	182	1.6 (1.4–1.9)
Single vehicle overturned	85	0.8 (0.6–0.9)
Collision with quad bike	78	0.7 (0.6–0.9)
Side swipe: opposite direction	71	0.6 (0.5–0.8)
Sudden mechanical failure	43	0.4 (0.3–0.5)
Side swipe: same direction	40	0.4 (0.3–0.5)
Collision with train	11	0.1 (0.05–0.2)
Other/unknown	328	3.0 (2.5–3.5)
Total	*11,253*	*100*

Table 5. Relative risk ratio of being injured or killed as a result of crash type.

Type of crash	Injured	Killed
Collision with pedestrians	1.0 (0.8–1.2)	**5.8 (3.2–10.5)**
Roll-overs	**2.7 (2.3–3.2)**	**7.6 (4.2–13.7)**
Head Side collision	**1.3 (1.1–1.6)**	1.9 (1.0–3.6)
Head rear collision	1.1 (0.9–1.3)	0.9 (0.5–1.9)
Hit and run	**4.7 (3.6–6.3)**	**26.5 (13.8–50.8)**
Head-on collision	**2.2 (1.9–2.7)**	**10.8 (5.9–19.7)**
Collison with fixed object	**1.9 (1.5–2.4)**	**4.0 (2.0–7.8)**
Lost control	**1.7 (1.4–2.1)**	**3.0 (1.5–6.0)**
Collision with cyclist	1.1 (0.9–1.4)	**3.6 (1.8–7.2)**
Side wipe collisions	**1.4 (1.1–1.8)**	**2.5 (1.2–5.2)**
Fell from moving vehicle	1.0 (0.7–1.3)	**4.7 (2.3–9.5)**
Collison with animal (domestic)	1.1 (0.9–1.4)	1.6 (0.7–3.5)
Chain collisions (Reference)	1	1
Collision with wild animal	**1.7 (1.4–2.1)**	**2.7 (1.3–5.6)**
Burst tyre	**2.5 (1.9–3.2)**	**5.3 (2.6–10.6)**
Single vehicle overturned	**1.6 (1.2–2.2)**	**5.1 (2.3–11.1)**
Collision with quad bike	1.0 (0.8–1.2)	**5.4 (3.0–10.0)**
Side swipe: opposite direction	**2.3 (1.9–2.8)**	**6.1 (3.4–11.1)**
Sudden mechanical failure	**2.4 (1.7–3.3)**	**4.4 (1.9–10.5)**
Side swipe same direction	1.3 (1.0–1.7)	2.0 (0.8–4.7)
Collision with train	1.5 (0.7–3.4)	**11.1 (3.0–41.2)**
Other/unknown	**2.0 (1.5–2.5)**	**5.8 (2.8–11.7)**

Results significant at the 5% level are shown in bold.

and their bodies are directly impacted when a crash occurs (NRSC, 2012). Despite evidence from NRSC (2015) showing that in Namibia most pedestrians get hit when trying to cross roads at undesignated locations in urban areas, there has not been any solid action taken towards improving this situation: urban areas almost entirely lack pavements, non-signalised pedestrian ('zebra') crossings, speed bumps and traffic lights due to the neglect of pedestrian facilities (Heidersbach & Strompen, 2013; Riehle, 2016). This illustrates an urgent need for authorities to invest in pedestrian infrastructure such as zebra crossings. According to AMEND (2016), this is a common feature in SSA: in most African cities, the neglect of pedestrians is clear in the absence of footpaths and safe crossings; the poor maintenance of those footpaths that do exist; the lack of speed control; and the lack of street lighting. Similarly, cyclists are at high risk when involved in crashes as they also lack the protective barrier which car occupants have (WHO, 2009). A lack of cycling lanes on standard roads in Namibia means that cyclists are at high risk of serious injury and death when involved in crashes as they are not separated from fast moving traffic and crashes (Heidersbach & Strompen, 2013).

Based on extensive research done in HICs, such as the work of Grundy et al. (2009), who found that the 20 mph traffic zones introduced in London, United Kingdom were associated with an approximate 40% reduction in casualties and collisions, the WHO (2015) advocated for every country to adopt national speed limits of 30 km/h in urban areas, where pedestrian and cyclist crashes are most likely to occur. However in Namibia, this has not been adopted and the national speed limit for urban roads is set at 60 km/h, a figure which is double the WHO recommended limit. When hit at such high speeds, the risk of death and serious injury for pedestrians and cyclists is exceedingly high. Based on the evidence showing significant reductions in severe injury and death with the 30 km/hr urban speed limits, there is an urgent need for Namibia to adopt and implement the WHO recommendations. Another consideration is that most cars in SSA are older cars which do not have 'pedestrian front protection' features such as having soft bumpers and modifiable front ends which can reduce severity of impact with pedestrians (WHO, 2018).

An area of concern with regards to the high risks that passengers have are taxis and minibuses, which are the commonest forms of public transport. Taxis often carry as many people as can fit, while minibuses often carry scores of passengers at a time (Madejski et al., 2014; NRSC, 2016). Frequently overcrowded, most of these vehicles lack seat belts and even when seat belts are available, compliance rates are very low. According to the NRSC (2016), in 2016 the proposed safety regulations regarding mandatory seatbelts for passengers in buses had not yet been passed. Moreover, to date, there are no official campaigns to improve seatbelt compliance rates in buses and taxis.

Another related area of concern is the practice in Namibia of carrying passengers in the back of pick-ups. Although statistics on the specific numbers and vehicle kilometres travelled (VKT) are not available, pick-ups are one the most popular types of cars in Namibia, and more generally in countries throughout SSA (Howlett et al., 2014). It is common practice in Namibia for pick-ups, also known locally as bakkies (Howlett et al., 2014), to carry passengers in the back/cargo area without any seatbelts or restraints because there is a severe shortage of public transport in Namibia (Kieck et al., 2016). It is likely that people are aware of the dangers associated with sitting or standing at the back of pick-ups but especially in rural areas, they have no alternative. Often the vehicle overturns with many passengers in the open back (NRSC, 2013). The NRSC reports that this practice is a persistent challenge in Namibia, resulting in a high number of crash injuries and deaths (NRSC, 2013). In the event of such a crash, even a minor one, the unrestrained individuals are likely to be ejected from the vehicle and have a much higher likelihood of sustaining serious injuries, including head and cervical injuries or death, than would be the case in a crash involving closed sedan-type vehicles (Howlett et al., 2014; NRSC, 2013).

According to Howlett et al. (2014), the dangers of the practice have been long recognized in HICs and this is prohibited in Europe and Australasia. However, there is no regulation at all on this in Namibia (NRSC, 2013) despite the fact that NRSC has acknowledged this as a serious problem. This may likely be because the NRSC have no regulative powers (WHO, 2018). Howlett et al. (2014) similarly report that in South Africa, although laws against having unrestrained passengers in the back of a pick-up exist, these are not clear and poorly enforced. It is likely that this practice is unregulated in most countries in SSA and there are no clear laws against the practice despite its danger in the event of a crash. This may be a major reason for the higher burden of RTIs in SSA, considering pick-ups are one of the most popular types of cars and is an important area for further study

Thus, one important way of reducing RTIs as well as reducing inequalities in Namibia would be to increase safer public transport options, both in urban and rural areas, which would reduce the need for people to rely on dangerous methods of travel such as 'bakkies' and mini-buses. There is also a need for stricter enforcement and public health campaigns to improve compliance of seat belt wearing, as well as instituting stricter measures such as fines and licence penalties for private cars, taxis, and minibuses to ensure that all passenger vehicles have functioning seat belts not only for the driver but for each passenger.

In the multivariate analysis, only risk of injury remained higher for females and there was no significant difference in risk of death by gender. The increased risk of injury to females could be that they are possibly more likely than males to be vulnerable road users. We could not find any official statistics on the gender distribution of road users in Namibia however there are considerably more male than female drivers (NRSC, 2016) with previous NRSC reports noting many more female passengers and pedestrians than drivers NRSC (2013, 2015, 2016). We showed that when all factors were taken into account, the type of road user had the greatest influence on the risk of having died or not, with motorcyclist and cyclists having the greatest risk compared with any other factors, including having been a pedestrian or a passenger. Of those involved in crashes, females composed only 4% of cyclists and 13% of motorcyclists.

We showed a significantly higher risk of dying on Saturday or Sunday than any other days, after adjustment for other relevant factors, with no significant findings by day of the week for risk of injury. A burgeoning literature shows that drinking varies at weekends compared with weekdays. Lower rates of alcohol use occur during the week but become elevated during the end of the week, reaching a peak on Saturdays (Lau-Barraco et al., 2016). Thus it is likely that the higher risk of death associated with Saturdays and Sundays may be associated with increased alcohol consumption. Another reason to explain the higher risk of dying at the weekend is that people are more likely to leave their daily routines and travel farther or go to places they are less likely to be familiar with, such as new restaurants or visiting family or friends at a distance.

The risk of death increased with advancing age, from 50 years upwards, with the highest risk in those aged 80+. This oldest age group were also at much higher risk of dying, given transfer to hospital. The results, showing greatly increased death risk in this age group, are also in line with other studies. For example, Feleke et al. (2018) found that fatality rates by both distance and time in

2007–2012 in England for cycling and walking were lower for younger age groups but the rates increased exponentially with age, especially in the upper age bands (70+). Similarly, Rolison et al. (2012) in Great Britain found an increased fatality rate in older drivers and pedestrians in 1989–2009. Older people are more likely to have other illnesses (co-morbidities). Co-morbidity increases the severity of the sequelae of a given event, except for the most severe injuries (Camilloni et al., 2008). According to the WHO (2018), the reason older road users, pedestrians in particular, are associated with a very high rate of road injury and death is mainly due to their increased physical frailty (WHO, 2004), consequent on these co-morbidities. Due to this, they are more likely to die given the same injury such that the fatality risk for car occupants increases for each year they age from about 21 years of age (Kahane, 2013).

Those transported by police and private vehicles after crashes were at very much higher risk of dying than those transported by ambulance. One possible explanation is that the individuals transported by police may have sustained further complications to their injuries due to incorrect lifting procedures when being moved from the crash sites in police vehicles. They may have also possibly been not given appropriate first aid to stabilize their injuries, for example minimization of blood loss, because the police lack training and equipment to address this. However, these would also apply to private vehicle use, where the raised risk was almost two orders of magnitude lower. A more important factor may be that those who were transported by police were in remote areas lacking any emergency care (EMC) services. Thus due to longer travel distances, they would be more likely to receive treatment later and could be prone to developing more complications before reaching the hospital. Another factor is that police may have been first at the scene of crashes and in cases where the injuries seem severe, they may decide not to wait for EMC services, believing it was a matter of urgency to transport the injured to the hospital. Thus this association may be an example of 'reverse causality' and is a limitation of our dataset and analyses and may also explain the raised RRR for many regions for death in hospital but significantly lower aRRR for the same regions in multivariate regression.

We found one other study in SSA which has looked at the method of transportation of those injured in crashes (Osoro et al., 2011). This study, in Kenya, found that 89% of those injured in RTIs were transported by private vehicles or taxis to hospital, with only 3% of the injured transported by ambulance services (Osoro et al., 2011). The figure of 89% is considerably higher than in Namibia, however the Kenyan study was based in one district and was done over a limited period of time so the findings may also not have been representative of Kenya nationally. However, it has been reported that EMC is lacking throughout SSA, which is an additional factor which appears to contribute to a much higher rates of death and disability when compared with other world regions when crashes occur (Moroz & Browner, 2014). Our findings provide additional evidence that this is an important variable and highlights the importance of EMC and the need for enhancing services across the country.

In light of our findings, an addition way to improve post-crash care for RTIs in Namibia would be for all police officers to receive basic life support training (first aid). This would be likely to be particularly useful in the remote areas where EMC services are not readily available. According to Taibo et al. (2016), considering the financial and resource constraints in LMICs, simple but systematic pre-hospital training programmes could be implemented in rural villages in LMICs to stabilize patients injured in road crashes. However, such training would be of benefit even in urban areas. Most pre-hospital deaths are the result of airway compromise, respiratory failure, or uncontrolled haemorrhage: each of these conditions can be addressed using basic first aid measures (Taibo et al., 2016).

5. Conclusion

This paper contributes to the discourse on RTIs, which are now a major global public health challenge and a leading cause of death, injury, and long term long-term disability worldwide. Unlike any other studies on RTIs in Namibia, we have conducted regression analysis and identified the groups with the greatest risks of being injured and killed which includes pedestrians and cyclists. Our findings suggest that the lack of public transport and EMC services are issues needing urgent attention. The Namibian population would benefit by the government implementing and enforcing laws such as 30k/hr urban limits, mandatory seatbelt use, and outlawing of carrying 'passengers' at the back of pick-up trucks. An effective mechanism would be empowering a central coordinating agency, such as the NSRC, to take leadership and coordinating responsibility, with regulatory powers. The need for major commitments by Government and civil society in Namibia to local and national campaigns to improve road safety knowledge and practice among all components of Namibian society is also a much needed 'next step' in lowering the rates of RTI related preventable injury and deaths. The new insights provided by our analyses and policy review project add to the understanding of RTIs in Namibia and present new information which can be of use to policymakers, public health and public safety officials, and civil society groups in formulating policies and programmes to protect those groups who have been identified as most vulnerable to RTIs.

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The authors declare that they have no competing interests.

Authors' contributions

MC conducted and analysed the qualitative data and was the main author in writing the manuscript. NG, JSM and MK all contributed to writing up and editing the manuscript. All authors read and approved the final manuscript."

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Ethics

This study was performed in line with the principles of the Declaration of Helsinki. Ethical approval was obtained from both the University College London Ethics Committee (No: 7417/001) and the Ministry of Health and Social Services in Namibia (No. 17/3/3).

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Availability of data and materials

The datasets generated and/or analysed during the current study are available in the (UCL depository).

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