Original Article

A Review of Fatal Road Traffic Accidents in Singapore from 2000 to 2004

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Abstract

Introduction: This retrospective study aims to assess the epidemiology of road traffic accident (RTA) fatalities in Singapore, other causes of death besides trauma in a RTA, and identify the groups at risk. Materials and Methods: Data of 1038 RTA fatalities were reported between 2000 and 2004. Analyses using the Fisher's exact test for discrete variables and multivariate Cox regression analysis were performed to identify groups at risk. The risk of fatality was measured using the prevalence rate ratio (PRR). Results: The median age of victims in the sample was 36 years (interquartile range 24 to 55). Eight hundred and thirty six cases (78%) were in the economically productive age range of 15 to 65 years. Over the 5-year period, there was a preponderance of males. Majority of fatalities involved multiple injuries. There were also 64 (6.2%) and 25 (2.4%) cases of RTA fatalities from infective and cardiovascular (CVS) causes, respectively. Multivariate analyses showed that those ≥ 60 years were 4 (95% CI of PRR, 3.04 to 5.43) times as likely to be pedestrian fatalities. Conversely, the risk of fatalities involving pedestrians and cyclists was reduced for males (PRR = 0.58; 95% CI, 0.46 to 0.73). However, males were at increased risk of fatalities involving motorcyclists, scooter and pillion riders (PRR = 1.96; 95% CI, 1.43 to 2.70), whereas such risk was reduced for those aged 30 to 59 (PRR = 0.70; 95% CI, 0.58 to 0.85) or ≥ 60 years (PRR = 0.30; 95% CI, 0.21 to 0.42), respectively. Conclusion: As such, it appears that the groups at-risk had varying demographic characteristics. Public education could be modified to target these different groups to reduce the number of fatalities.

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Key words: Fatality, Motorcyclists, Pedestrians, Risk, Road traffic accident(s)

Introduction

As countries become more developed, there is often an accompanying rise in life expectancy. However, increasing motorisation that accompanies economic growth has led to an increase in road traffic accidents (RTAs), and a corresponding rise in fatalities. Indeed, the World Health Organization has predicted that traffic fatalities will be the sixth leading cause of death worldwide and the second leading cause of disability-adjusted life-years lost in developing countries by the year 2020.[1]

Road traffic fatalities in western countries mainly involved car drivers and passengers, with the latter comprising 15 to 20 percent. In Asian countries, a wide variation was found. For example, Hong Kong reported almost 70 percent of pedestrian deaths and Korea, about 50 percent. Conversely in China, Malaysia and Thailand, over 50 percent of deaths involved motorcyclists, while pedestrian deaths were surprisingly low at around 10 to 15 per cent of the total.[2]

Locally, statistics provided by the Traffic Police Department[3] showed a steady decline in the road fatality rate from 7.5 per 100,000 population in 1995 to 5.1 per 100,000 population in 1999. The local fatality rate per 10,000 vehicles for 1999 was higher at 2.9, as compared to other developed countries: 1.3 in Japan, 1.4 in the United Kingdom and 2.1 in the United States. This was, however, lower than those of our neighbouring countries: 8.2 in Malaysia, 8.6 in Thailand and 9.7 in Indonesia.

The objectives of this study were to:

i) Document the demography and trend of road accident fatalities in Singapore between 2000 and 2004,

ii) Identify the causes of death (other than trauma) in an RTA, and

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iii) Identify the groups at risk.

This study was facilitated by the local medico-legal system, wherein every victim of a fatal road accident was subjected to a Coroner's autopsy conducted at the Centre for Forensic Medicine (CFM).

Materials and Methods

For each fatality case, the following information was documented:

1. Biodata (age, sex and ethnicity)

For the purpose of analysis, data on age was categorised into 3 intervals: <30, 30 to 59 and ≥60 years. Similarly, ethnicity was classified as Chinese, Malay, and Indian (the 3 major ethnic groups in Singapore) and others.

2. Mode of accident fatality

Vehicular fatalities were grouped according to the type of motor vehicle that was involved. Under the Road Traffic Act,[4] there are 4 main classes of motor vehicles.

Class 2: Vehicles with less than 4 wheels and the weight of which unladen does not exceed 400 kg, namely motorcycles and scooters.

Class 3: Vehicles that do not exceed 3000 kg and with no more than 7 passengers exclusive of the driver; or in any other case, motor vehicles that do not exceed 2500 kg, namely cars, taxis, pick-ups, vans, minibuses and police land rovers.

Class 4: Vehicles which are constructed themselves to carry a load or passengers and the weight of which unladen exceeds 2500 kg;

Class 5: Vehicles which are not constructed themselves to carry any load (other than any of the articles specified*) and the weight of which unladen does not exceed 7250 kg.

In this study, Class 4 and 5 vehicles were grouped together because of their similarity as heavy vehicles with weight of which unladen exceeds 2500 kg, e.g. buses, tippers (mud transport trucks) and lorries.

Similarly, we classified fatalities involving: (i) riders and pillions of motorcycles and scooters as Class 2, (ii) drivers or passengers of Class 3 vehicles as Class 3, (iii) drivers or passengers of Classes 4 and 5 vehicles as Class 4 and 5, respectively. In addition, we defined pedestrian or cyclist fatalities as Class 1 because of their common characteristic as "unprotected" individuals.

3. Cause of death (COD)

The purposes of autopsy were to: (i) clarify the relationship between death and the accident, and (ii) examine whether the accident was a hit-and-run case.[5] When there was more than one cause of death, the first listed was accepted as the main contributing factor. Similar CODs were grouped together for analysis. Underlying or intercurrent pathology was also recorded.

The information was compiled and analysed using SPSS version 13. Data entered was double-checked, and errors found were changed to improve the accuracy. The characteristics of the cases were presented in frequencies and percentages. Prevalence rate ratios and their corresponding 95% confidence intervals were computed as measures of risk of the respective mode of fatalities. Chi square test was used to evaluate differences in risk between modes of accident fatalities. Cox regression analysis was implemented to identify groups at-risk.

Results

This retrospective study was conducted on medico-legal autopsies performed on 1079 consecutive road traffic accident fatalities, between 1 January 2000 and 31 December 2004, at the CFM. A total of 1038 cases were analysed. These excluded 2 cases each of unknown age and ethnicity, and 37 cases that occurred overseas with minimal details of the accident being recorded.

Demographics

The incidence of road traffic accidents[6] has remained relatively stable over the 5-year period varying from 12.2 to 14.2 per 1000 deaths (Table 1).

The distribution of RTA fatalities by age was skewed towards the younger age groups with the highest occurrences (32.5%) in the 20 to 29 year old range (Fig. 1 and Table 1). The median age of victims in the sample was 36 years old (interquartile range 24 to 55). Notably, 836 (77.5%) of the victims were in the economically productive age range of 15 (legal age to start work) to 65 (official retirement age)[7] years.

There was a preponderance of males comprising 82.8% of all cases. However, a slight increase in female RTA fatalities was observed for 2003 and 2004.

The overall ethnic composition was 66.2% Chinese, 13.6% Malay, 11.2% Indian and 9.1% Others. No significant change was noted in the ethnic distribution during the 5-year period.

Class 2 fatalities involving motorcyclists, scooter and pillion riders ranked the highest (46.3%) in our study. This was followed by Class 1 fatalities involving pedestrians and cyclists (33.8%), and Class 3 fatalities involving motorists and their passengers (14.8%), respectively.

The top COD was multiple injuries (46.8%) (Fig. 2), defined as involving 2 or more body regions (predominantly the head, thorax and abdomen). This was followed by fatalities resulting from head injuries (30.9%).

* water, fuel, accumulators and other equipment and materials used for the purpose of propulsion, loose tools and loose equipment.

Table 1. Distribution of RTA Fatalities from 2000 to 2004

Year	2000	2001	2002	2003	2004	
Total No. of deaths	15,692	15,367	15,820	16,033	15,860	
Total no. of RTA fatalities	223	195	193	213	214	
Incidence per 1,000 deaths	14.2	12.7	12.2	13.3	13.5	
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**% of total fatalities over 5 years**
Age						
<30	86	83	84	82	77	39.7
30-59	88	72	61	83	97	38.6
≥60	49	40	48	48	40	21.7
Gender						
Male	190	161	163	176	169	82.8
Female	33	34	30	37	45	17.2
Ethnicity						
Chinese	146	133	128	139	141	66.2
Malay	28	33	25	28	31	13.6
Indian	24	24	18	20	26	11.2
Others	25	5	22	26	16	9.1
Mode of fatality						
Class 1	72	71	64	76	68	33.8
Class 2	103	82	100	94	102	46.3
Class 3	34	29	23	36	32	14.8
Class 4 and 5	14	13	6	7	12	5.0

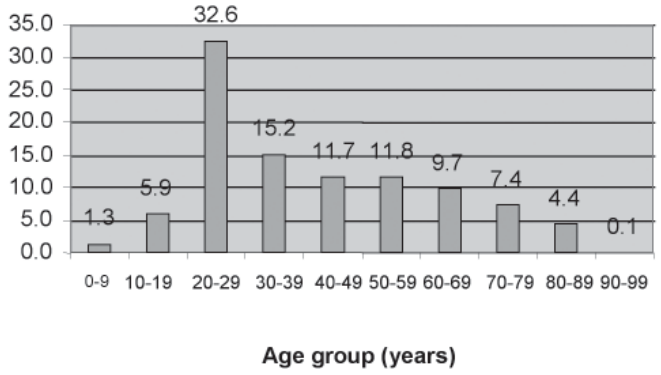

Fig. 1. Distribution of RTA fatalities by age group.

Altogether, there were 64 (6.2%) fatalities due to an infective cause (Table 2). Of these, there were 36 fatalities (3.5%) due to lung infections with the majority being bronchopneumonia. A third of these 36 cases were in the 20 to 39 years old group. There were 28 fatalities (2.7%) due to sepsis, with 21.4% of these being in the 20 to 29 years old group.

There were 25 (2.4%) cardiovascular (CVS) deaths, of which myocardial infarction or ischaemic heart disease was the main cause of death. Thirty-six percent of those who died from this cause were in the 60 to 69 years old group.

The category 'Others' consisted of miscellaneous causes which did not fall into the main categories e.g. decapitation, traumatic asphyxia etc.

Among the top 2 modes of fatalities, principal fatal injuries were as follows: Class 2 fatalities mainly died of multiple injuries (49.9%), followed by head injuries (29.3%). Class 1 fatalities had a similar distribution, with 44.8% having multiple injuries and 34.8% having head injuries. However, there was no discernible relationship between the principal fatal injuries sustained and the types of vehicles involved.

Groups at-risk

As shown in Table 3, those ≥60 years old or females were at higher risk of being victims of Class 1 fatalities, involving a total of 351 pedestrians and cyclists. Results from the multivariate analysis showed that significantly (P <0.001), those ≥60 years old were 4 (95% CI of PRR, 3.04 to 5.43) times as likely to be victims of Class 1 fatalities. Conversely, the risk of pedestrian fatalities was reduced for males (PRR = 0.58; 95% CI, 0.46 to 0.73). Ethnicity

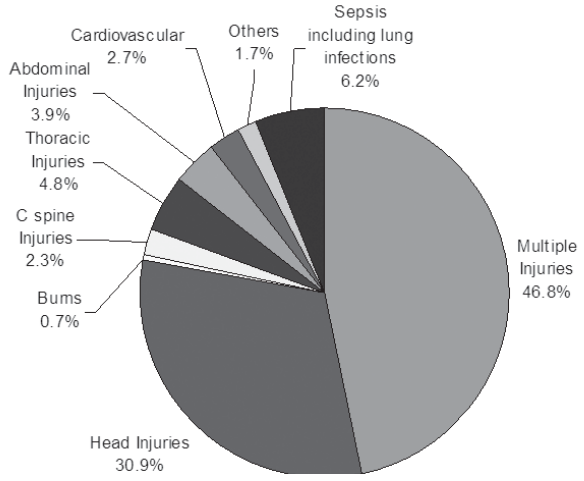

Fig. 2. Distribution of RTA fatalities by Cause of Death (COD).

Table 2. Distribution of COD due to Infective and CVS Causes

Cause of death			
Infection		**Number**	**Percentage**
i) Sepsis	sepsis following traumatic injuries	17	26.6
	sepsis following bronchopneumonia and traumatic injuries	9	14.1
	sepsis following perforated ulcers	2	3.1
ii) Lung infection	Bronchopneumonia	35	54.7
	Undiagnosed chest infection	1	1.6
Total		64	100
CVS causes	Myocardial Infarction/ Ischemic Heart Disease	23	92
	Ruptured aortic aneurysm	1	4
	Dilated cardiomyopathy	1	4
Total		25	100

was not found to be significantly associated with Class 1 fatalities (P = 0.141) (Table 3).

Among the Class 2 fatalities (n = 481), the victims were predominately males and in the younger (<30 years) age group (Table 4). As compared with females, the risk of Class 2 fatalities amongst males was double-fold (adjusted PRR = 1.96; 95% CI, 1.43 to 2.70). Similarly as compared with the <30 years old, such risk were reduced for the 30 to 59 years old (PRR = 0.70; 95% CI, 0.58 to 0.85) and ≥60 years old (PRR = 0.30; 95% CI, 0.21 to 0.42), respectively. Ethnicity was not found to be significantly associated with Class 2 fatalities (P = 0.069) (Table 4).

There were 154 cases of Class 3 fatalities. Ethnicity, age and gender were not found to be associated with these Class 3 fatalities.

Fifty-two cases of Class 4 or 5 fatalities were observed in this study. Statistical tests of significance were not conducted to evaluate age, gender, ethnicity and COD as possible risk factors of Class 4 or 5 fatalities because the sample size was relatively small and any differences detected were very likely due to chance.

Discussion

Currently, trauma is the fifth leading cause of death in Singapore.[8] Since 1986, RTAs have been reported to be the second most common cause of deaths from injuries, with falls being the leading cause.[9] In a similar study on road traffic accident mortality in Singapore based on data collected from 1995, Wong et al reported a median age of RTA fatalities of 31 years, with a male preponderance (82.3%).[9] In comparison, our results in Table 1 bring to attention the magnitude of the problem – incidence of RTA fatalities has been consistently above 12 per 1000 deaths per year from 2000 to 2004. It is sobering to note that in our study, 78% of the fatalities were in the age range of 15 to 65 years, which amounts to a significant loss to both society and the economy.

The analysis shows that victims of Class 2 fatalities are likely to be young males. Interestingly, Lateef reported a proportionately higher representation of Malays in a prospective study of 1809 motorcyclists that presented to an Accident and Emergency Department between 2000 and 2001, as compared with their composition in the population of Singapore.[10] However, in our study, a proposed relationship between ethnicity and Class 2 fatalities was not found to be statistically significant (P = 0.069). A number of behavioural risks[11] such as drunk driving, not using seat belts and speeding have also been identified. Yet so far, there has not been any in-depth study to understand their determinants. This study forms the basis for further investigation of the behaviours of certain groups of road users, especially the motorcyclists, in an attempt to design a programme to modify behaviour risks.

Class 1 fatalities are more likely to involve the older age group and female gender. The leading COD is multiple injuries followed by head injuries. In a study on pedestrian fatalities in Singapore between 1990 and 1994, Lau et al[12] reported that those ≥60 years or in the 30 to 59 age range accounted for 43.9% and 33.3%, respectively of all

Table 3. Risk Factors for Class 1 Fatalities involving Pedestrians and Cyclists

Category	Number	Prevalence %	Crude prevalence rate ratio, PRR	Adjusted PRR (95 % CI) using Cox regression model
Age				
<30	67	16.3	1.00	1.00
30-59	122	30.4	1.87	1.83 (1.35-2.46)
≥60	162	72.0	4.43	4.06 (3.04-5.43)
Gender				
F	104	57.8	1.00	1.00
M	247	29.0	0.501	0.58 (0.46-0.73)
Ethnicity				
Chinese	252	36.7	1.00	1.00
Indian	45	38.8	1.06	1.32 (0.96-1.82)
Malay	29	20.6	0.561	0.79 (0.53-1.16)
Others	25	26.6	0.725	0.88 (0.58-1.33)

Table 4. Risk Factors for Class 2 Fatalities involving Motorcyclists and Pillions

Category	Number	Prevalence %	Crude prevalence rate ratio, PRR	Adjusted PRR (95 % CI) using Cox regression model
Age				
<30	267	64.8	1.00	1.00
30-59	175	43.6	0.673	0.700 (0.577-0.849)
≥60	39	17.3	0.267	0.297 (0.211-0.416)
Gender				
F	42	23.3	1.00	1.00
M	439	51.0	2.19	1.96 (1.43-2.70)
Ethnicity				
Chinese	280	40.8	1.00	1.00
Indian	56	48.3	1.18	1.03 (0.771-1.37)
Malay	95	67.4	1.65	1.37 (1.08-1.73)
Others	50	53.2	1.31	1.15 (0.854-1.56)

pedestrian fatalities, both values being very similar to our study's. Teanby et al[13] also reported that although there was male preponderance, there was a slight inversion of the male to female sex ratio amongst elderly pedestrian fatalities. However, multivariate analysis was not carried out in his study.

Currently, about 8% of the population is ≥65 years old. In 25 years' time, it is projected that this figure may top 18%. Alerting families of the dangers that their elderly face on the road may reduce such fatalities. The public could also be warned of local hazardous road locations that have been verified and mapped out using the Geographic Information System (GIS).[14]

The results from our multivariate analysis appear to correlate with a similar study from Japan, which also found that those who were involved in accidents while they were on foot, were overwhelmingly aged 70 years or above, and those who were involved in accidents while they were riding motorcycles were predominantly in their 20's.[5]

Among the RTA fatalities in this study, the top cause of death was multiple injuries. It is thus prudent to enlist different specialties to manage an RTA patient on arrival to a hospital.

It was interesting to note that 64 cases (6.2%) of mortality

results from infection. This was the third COD after multiple injuries and head injuries. They occurred mostly in the 20 to 29 years old group, which was presumed to be a healthy lot. Data was unavailable as to whether inappropriate antibiotics contributed to this. Further study on the culture and sensitivity of the organisms that affect this group of people may assist in developing empirical antibiotics for treatment.

The proportion of subjects dying from cardiovascular (CVS) causes (2.4%) was comparable to that found in other studies. Lau reported 35 (2.7%) out of 1285 RTA fatalities resulting from natural causes in a retrospective study in Singapore between 1989 and 1993.[15] He also reported a high prevalence of intercurrent disease (59% IHD, 30% hypertensive heart disease and 18% chronic obstructive pulmonary disease and bronchopneumonia) among pedestrian fatalities in another 5-year study period.[12] In our study, most of the fatalities from CVS causes died from myocardial infarction or ischaemic heart disease. This was similar to the study by Buttner et al which reported ischaemic heart disease as the main cause of death in 113 out of 147 cases of natural cause of death at the wheel.[16] The acute onset of transmural MI is precipitated either by vasospasm or haemodynamic stress, while the global borderline perfusion in subendocardial MI is made transiently critical also by the above-mentioned reasons. These might be induced by the stress associated with even a minor accident. Nonetheless, the small proportion of CVS cause of death observed is consistent with previous investigations that sudden natural deaths at the wheel are rare events in proportion to traumatic deaths.[15-17]

Strengths of this study

1. Under the Singapore medicolegal system, every victim of a fatal RTA is subjected to a coroner's autopsy. Traffic crash fatalities are also defined within 30 days after a crash. Thus all RTA fatalities were recorded and analysed. This is not the case in many other countries e.g. Thailand, Malaysia and Indonesia.
2. The 5-year study period provides a good window to study the recent trends of RTA fatalities.

Limitations of this study

1. There were other factors which were not studied that might have a bearing on the total number of fatalities e.g. the ambulance response times,[18] and the quality of care delivered pre-hospital and in the hospital.
2. The presence of alcohol or substance abuse as a causative factor of fatalities was not available for analysis.

Conclusion

This study has documented the trends of RTA fatalities in terms of demographic parameters between 2000 and 2004. It has shown age and gender as the likely risk characteristics of the top 2 modes of fatalities. Other causes of death besides injuries in a RTA victim have been identified. The possible applications of these results in public education and hospital care have also been explored.

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