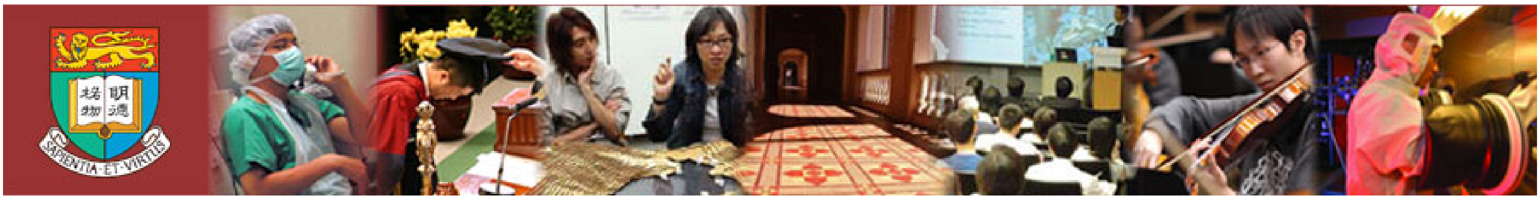

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Age as a Risk Factor in Pedestrian Traffic Casualties

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Abstract

This paper makes use of a linked hospital database, the Road Casualty Information System (RoCIS), to examine age as a risk factor in pedestrian traffic casualties. The database consisted of 4,290 traffic casualty records admitted to two major hospitals in Hong Kong in 2004. Among these records, there were 897 pedestrian traffic casualties (PTC) and 3,367 non-pedestrian traffic casualties (NPTC). Statistically, there was no significant age difference among the two groups. However, the severity of injury differed significantly at the 0.05 level.

In order to conduct a more in-depth analysis of the age factor in affecting the severity of injuries, the pedestrian traffic casualties were divided into four age groups. A set of five injury severity variables were calculated for different age groups. For PTC, all injury severity indicators increased by age. The picture was less clear for NPTC. Theoretically, there are many confounding factors, such as gender, vehicle class and injury patterns, to injury severity. The relationships of these risk factors with the five injury severity variables are analyzed by logistic regression. Overall, the results clearly point to the importance of age as a risk factor. In all models, the elderly (≥65 years) were having higher chances of serious injury and fatality. The odd ratios imply that elderly PTC were about twice more likely to die and to suffer from serious injury than younger ones. In addition, multiple injuries and heavy vehicles also increased the chance of severe injury among PTC.

1. Introduction

Research worldwide has shown that age is a significant risk factor in affecting the injury outcome especially mortality rate. Bergeron et al studied on a group of rib fracture patients and indicated that age was an independent predictor of in-hospital mortality with an elderly patient having 5 times risk of death compared to a younger adult.[1] Similar findings occur in road traffic injuries casualties. The total fatality rate of the elderly traffic injury group was reported to be almost double of the younger group.[9] Elderly drivers aged 65-69 years were shown to be 1.29 times more at risk of being involved in fatal crashes and drivers of age 85 years or more were 3.74 times more at risk when compared to drivers aged 40-49.[6] The situation in elderly pedestrians is less clear as most of the studies on elderly traffic causalities were on drivers or occupants. Particularly, the relationship of age and injury severity other than mortality remains as a significant knowledge gap.[3]

In this study, we aim to examine the significance of age on injury severity of pedestrian casualties and determine whether being elderly in age will increase the likelihood of having serious injury or mortality in pedestrian trauma adjusted for other variables.

2. Patients and Methods

This study nested on a linked database, known as Road Casualty Information System (RoCIS), which included both the hospital trauma data and police crash investigations data known as the Traffic Road Accident Databases (TRADS) for all traffic casualties treated in Tuen Mun Hospital and Queen Mary Hospital in Hong Kong. Tuen Mun Hospital and Queen Mary Hospital are among the 5 designated trauma centres in Hong Kong and the 2 hospitals have a combined serving population of above 2 millions. The 2004 RoCIS database included 4,290 traffic casualty records (consisting of 3,034 records from Tuen Mun Hospital and 1,256 records from Queen Mary Hospital). Out of the 4,290 cases, there were 897 (20.9%) pedestrian traffic casualties (542 from Tuen Mun Hospital and 355 from Queen Mary Hospital) and 3,367 non-pedestrian (79.1%) traffic casualties.

In this study, all traffic casualties were divided into 4 age groups (≤14 years, 15-54 years, 55-64 years and ≥65 years). Those of 65 years old or above were considered as elderly patients. Severity of injuries was measured by different indictors including ISS, mortality rate and length of stay in hospital. Injury of ISS>8 was defined as severe injury. Injury of ISS >15 was defined as severe trauma. Injury of ISS>30 was defined as critical trauma. Hospital stay of 1 week or more also indicated to a serious level of injury. Injured body parts were divided into 4 regions namely 1) head and neck 2) upper extremity 3) lower extremity and 4) trunk (thorax, abdomen, and pelvis).

In order to examine age as a risk factor in pedestrian traffic casualties, we first establish whether its effects are different for pedestrians as a road user group. The proportion of serious injury, as measured by different severity indicators, in different age groups for both pedestrian traffic casualties (PTC) and non-pedestrian traffic casualties (NPTC) were calculated to establish the overall significance of age on traffic casualties. The PTC group was compared to NPTC group by t-test for age and Chi-square test for other variables. Statistical significant was defined at the level of $p<0.05$.

An in-depth analysis of pedestrian injury patterns was conducted to examine the impact of age as an independent predictor for serious injury and mortality. Theoretically, there are many confounding factors to injury severity and mortality and they include gender, vehicle class, time of the day, day of the week and injury pattern. We performed logistic regression analyses to examine the independent significance of these variables on each severity indicator (dependent variable). The relationships of these confounding factors with the injury severity variables were first screened using the Chi-square tests. Only those variables with statistically significant relationships i.e. passed the Chi-square tests at the 95% confidence level would be included in the final model of logistic regression analysis. Due to the consideration of significant difference in anatomical characteristics between a child and an adult, pedestrian casualties with age <15 years would be excluded from this part of analysis.

3. Results

There were 897 (20.9%) pedestrian traffic casualties (542 from Tuen Mun Hospital and 355 Queen Mary Hospital) and 3,367 non-pedestrian traffic casualties. Proportion of elderly casualties in PTC and NPTC were 16.0% and 4.5% respectively. Percentage proportion of PTC and NPTC with different severity indicators by age groups were shown in Figure 1 and Figure 2 respectively. For the PTC group, proportion of casualties increased by age for all injury severity indicators related to hospital stay, injury severity and mortality. For the NPTC group, the trend was less clear-cut and increased by age for only 2 indicators i.e. ISS>8 and length of stay of 1 week or more.

Figure 1 about here.

Figure 2 about here.

Further comparisons by Chi-square tests and *t*-tests between the 2 groups were shown as in Table 1. The results showed that, though the mean age of the PTC group was higher (75.43 years), there was no significant age difference between the PTC and NPTC groups. Nonetheless, the level of injury did differ significantly among the two groups. The differences were statistically significant at the 0.05 level for all injury severity indicators, including hospital stay of 1 week or more, severe injury (ISS>8), severe trauma (ISS>15), critical trauma (ISS>30) and the mortality rate. In particular, the severe trauma rate of the PTC group (4.7%) was more than six times higher than the NPTC group (0.7%). Notably, the PTC group (3.0%) was having a mortality rate more than four times higher than the NPTC group (0.7%).

Table 1 about here.

For the analysis of independent significance of age on the occurrence of different severity indictors, only the variables of vehicle type and injury pattern were included into the final model of logistic regression analysis as they passed the Chi-square tests at 95% confidence level.

The results of logistic regression with hospital stay of 1 week or more were shown in Table 2. Statistically significant factors at the 0.05 level were ≥65 years, heavy vehicles and the primary injury part (all four parts were statistically significant). Pedestrians hit by heavy vehicles (buses/container trucks/lorries/school buses) were about 2.35 times more likely to be hospitalized for one week or more. Pedestrian traffic casualties with primary injury of the lower extremity had the highest chance of hospitalization of 1 week or more. In comparison to pedestrian traffic casualties with primary injury of the lower extremity, those with primary injury of head and face (OR=0.40), body trunk (OR=0.24), and extremity (OR=0.28), were all having odds ratio lower than 1.

Table 2 about here.

The results of logistic regression with serious injury (ISS>8) were shown in Table 3. Statistically significant factors at the 0.05 level were ≥65 years, multiple injury, and heavy vehicles. The chance for pedestrian traffic casualties having multiple injuries to sustain serious injury (ISS >8) was about 2.26 times higher than those without multiple injuries. Similarly, the chance for pedestrians hit by heavy vehicles were about 1.90 times more likely to have injury of ISS>8.

Table 3 about here.

For serious trauma (ISS>15), only the factors of ≥65 years, head and face as the primary injury part, body trunk as the primary injury part and heavy vehicles were statistically significant at the 0.05 level. Of particular interest was that pedestrians with head and face injuries were 16.25 times more likely to be suffering from serious trauma than others with lower extremity injury. The chance for pedestrians with body trunk as the primary injury part was 18.24 times more likely to be in serious trauma than those with lower extremity injury. The impact of heavy vehicles was also noteworthy because they increased the chance of serious trauma by 2.46 times. For critical trauma (ISS>30) and mortality, only ≥65 years was statistically significant at the 0.05 level.

Overall, the results of the logistic regression clearly pointed to the importance of age as an independent risk factor for serious injury level among pedestrian traffic casualties. Elderly victims were shown to have higher chances of suffering from more severe type of injury and fatality in the event of pedestrian-vehicle crash (Figure 3). They were about four times more likely to die (OR=3.80; 95% CI=1.24, 11.65) and to have hospital stay of one week or more (OR=4.25; 95% CI=2.49, 7.26) after a pedestrian-vehicle crash when compared to adult of age less than 65 years.

Figure 3 about here.

4. Discussion

We have shown that age is a significant independent factor for higher injury severity and mortality in pedestrian casualties. One recent study by Demetriades et al also reported that age had an important role in the severity of injuries and survival outcomes after pedestrian injuries. They reported crude odds ratios of 4.62 and 6.87 for elderly pedestrian to have injuries of ISS>15 and ISS>30 respectively when compared to child pedestrian.[2] The results are similar to our findings of odds ratio of 2.46 and 5.38 respectively but we compare elderly to adult pedestrian. Critically, their results were based on univariate analysis without controlling of possible confounding factors. We regard our results being more superior because we have delineated the independent effect of age adjusted for various confounding factors to the outcomes. Nonetheless, this study also suffers from certain limitations. For instance, we did not control the confounding effect of vehicle speed because of significant missing data. Factors of crash location and pre-injury co-morbidity were also not controlled because RoCIS did not collect such information. The classification of injured body parts into the 4 regions as adopted by this study could be arguable. To include thorax, abdomen and pelvis into one single group may be too crude and over-simplified. The reason for not using the traditional six body regions classification system was related to the limited number of patients included in this study.

In Hong Kong, the pattern of road users group is quite different from that in US. We have relatively less elderly drivers but much more elderly pedestrians involving in road crashes. According to the 2005 Hong Kong Government Statistics, there were 346 (1.7%) elderly out of a total of 20,850 drivers involved in traffic crashes,[7] whereas there were 832 (18.9%) elderly pedestrian casualties or above out of total 4,404 pedestrian casualties.[8] A similar trend was reflected in our dataset. In our sample, 16.0% of the PTC group was elderly patients and 4.5% of the patients in the NPTC group were elderly. The situation can partly be explained by the fact that owning a car and to drive is very expensive in Hong Kong. Therefore most of the elderly and retired persons would prefer to use the cheap and convenient public transport system or simply to walk. As similar to other Asian metropolitan cities, Hong Kong is facing the problem of aging population. The proportion of elderly pedestrian casualties will continue to rise and certainly they will become an important healthcare problem or issue in the future.

To delineate the special characteristics associated with elderly trauma are important to develop effective treatment and prevention strategy. However, little research has been done on this issue in the past, and one possible reason may be the lack of good quality database. In Hong Kong as in many other regions, traffic crash research relies primarily on the police crash database. It has been demonstrated that the crude tripartite classifications (slight injury, serious injury and fatal) adopted by the Hong Kong Police was associated with significant misclassification error especially on serious injuries.[4] In addition to that, only less than 60% of all traffic injuries would report to the police in Hong Kong and the pedestrian group of casualties were significantly less likely (OR=0.49) to report to the police than the driver group.[5] The lack of details on injury itself further weakens the usefulness of police database for conducting in-depth analysis. The useful information collected by RoCIS for this study has exemplified the importance of hospital data as a supplement to police data for research on traffic medicine and science.

5. Conclusions

We have identified age as a risk factor for serious type of injury and mortality in all traffic casualties. The impact is much higher for pedestrians than the other groups of traffic casualties. After taking into account the injury pattern and the type of vehicle involved, being 65 years old or more will increase the risk of various serious injury rates by 2.46 to 5.38 times. Further research should be conducted in order to define the casual relationship of age to increasing injury severity.

Acknowledgements

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Table 1. Comparison between elderly pedestrian and elderly non-pedestrian casualties for selected injury severity indicators.

	Elderly pedestrian traffic casualties	Elderly non-pedestrian traffic casualties	p-value
Total number	145	153	--
Mean age (years)	75.43	73.39	0.916
Hospital stay of 1 week or more (%)	16.8	11.2	0.007
Severe injury rate (ISS>8) (%)	14.4	9.2	0.008
Severe trauma rate (ISS>15) (%)	4.7	0.7	0.001
Critical trauma rate (ISS>30) (%)	2.7	0.7	0.026
Mortality rate (%)	3.0	0.7	0.014

Table 2. The results of the logistic regression with hospital stay of more than one week

	B	S.E.	Wald	df	Sig.	Odd Ratios (OR)	95.0% C.I. for OR	
							Lower	Upper
Constant	-2.714	.286	90.015	1	.000	.066		
VOld65(1)	1.447	.274	27.961	1	.000	4.249	2.485	7.264
PrimInj			16.620	3	.001			
PrimInj(1)	-.929	.335	7.682	1	.006	.395	.205	.762
PrimInj(2)	-1.444	.554	6.798	1	.009	.236	.080	.699
PrimInj(3)	-1.289	.419	9.457	1	.002	.275	.121	.627
MultipleI(1)	.556	.306	3.310	1	.069	1.744	.958	3.176
HeavyVeh1(1)	.854	.282	9.189	1	.002	2.350	1.353	4.083

Inj= lower extremity, Inj(1)=head and face, Inj(2)=trunk of body, Inj(3)=upper extremity

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Table 3. The results of the logistic regression with severe trauma (ISS>8)

	B	S.E.	Wald	df	Sig.	Odd Ratios (OR)	95.0% C.I. for OR	
							Lower	Upper
Constant	-23.303	2206.854	.000	1	.992	.000		
VOld65(1)	1.060	.436	5.919	1	.015	2.886	1.229	6.779
PrimInj			7.509	3	.057			
PrimInj(1)	2.788	1.039	7.206	1	.007	16.253	2.122	124.477
PrimInj(2)	2.904	1.104	6.922	1	.009	18.243	2.097	158.708
PrimInj(3)	-15.850	3092.452	.000	1	.996	.000	.000	.
MultipleI(1)	17.792	2206.854	.000	1	.994	53342972.828	.000	.
HeavyVeh1(1)	.901	.425	4.485	1	.034	2.462	1.069	5.668

Inj= lower extremity, Inj(1)=head and face, Inj(2)=trunk of body, Inj(3)=upper extremity

Figure 1. Percentage proportion of PTC with different injury severity indicators by age groups

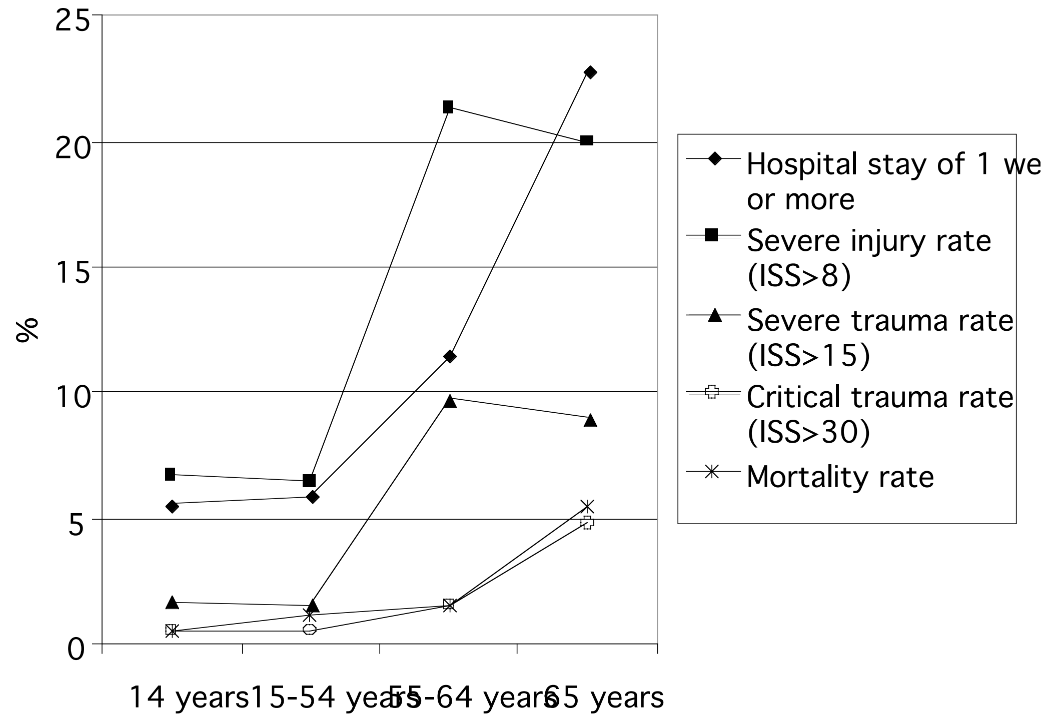

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Figure 2. Percentage proportion of NPTC with different injury severity indicators in by age groups

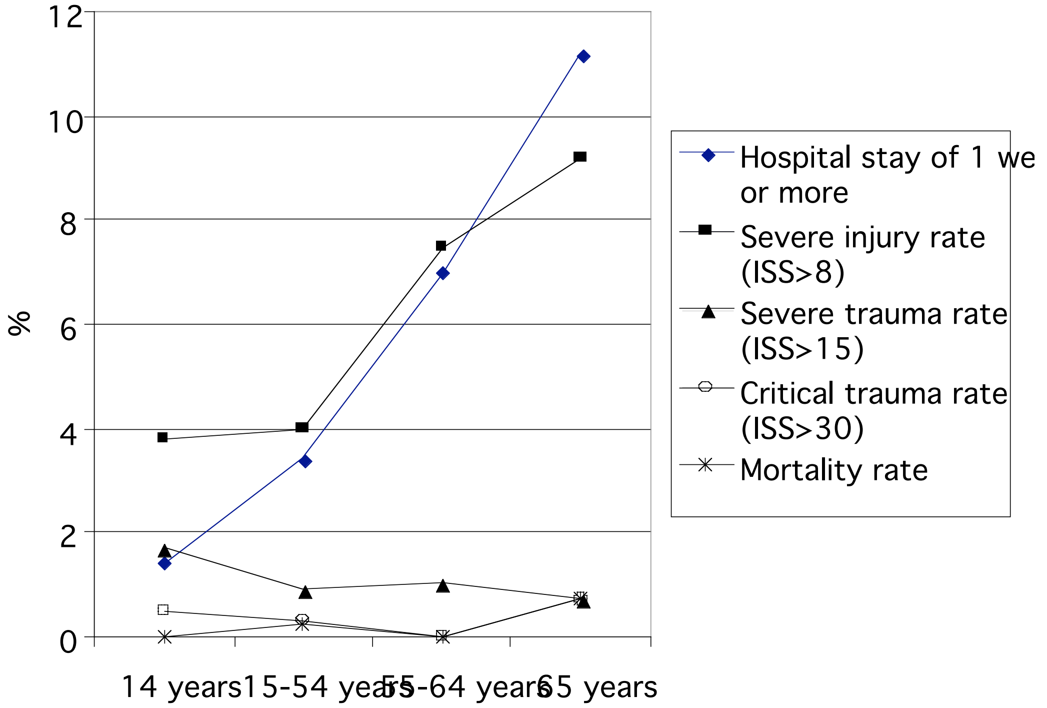

Figure 3. Adjusted OR of age ≥ 65 on different severity injury indicators