



## Characteristic and Introspection of Road Traffic Injuries in China from 2012 to 2017

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(Received 14 Feb 2020; accepted 19 Apr 2020)

### Abstract

**Background:** To analyze whether the area differences of RTIs (road traffic injuries, RTIs) caused by unequal development in China, provide suggestions for the prevention of the RTIs.

**Methods:** The data of RTIs in China was collected from the authoritative official website and yearbook of China.

**Results:** Total RTIs in the East was the highest (RTIs frequency: 591789; injured people: 600611; death toll: 168885; economic loss: 27.22 billion RMB), followed by the Center (RTIs frequency: 321807; injured people: 352769; death toll: 91966; economic loss: 23.90 billion RMB) and the lowest in the West (RTIs frequency: 289482; injured people: 332517; death toll: 101095; economic loss: 16.35 billion RMB). The multivariate linear correlation and regression showed that the characteristic of RTIs was highly related with GDP ( $r=0.99$ ,  $P < 0.001$ ).

**Conclusion:** The economically developed areas had a large amount of traffic damages. The government should focus on preventing high RTIs in the East and high death tolls in the West.

**Keywords:** Traffic accident injuries; Unequal development; China

## Introduction

Road traffic injuries (RTIs) are the main causes of death, hospitalization, disability, and direct economic loss around the world. The WHO reports that 90% of the world's fatalities on the road occur in low- and middle-income countries (1). Around 1200 thousand people all over the world are killed in vehicle-related crashes annually, between 20 and 50 million become disabled or wounded (2). The WHO reported a global estimate of 1.25 million road traffic deaths

per year, and one fifth of the deaths occurred in China (3).

RTIs in China have been on the rise, especially since the late 1980s, despite an 81% increase in the traffic-related mortality from 1987 to 2006 (4). In 2009, road traffic deaths accounted for about 70,000 premature deaths due to road traffic accidents injuries in China (5). New research shows that RTIs have become the leading cause of injury related death and a primary cause of dis-



ability and the third leading cause of life loss in China (6, 7). Therefore, RTIs has been recognized as an important public health in China.

Although major patterns of traffic crashes in China have been reported (5), China's previous studies had mainly described the changes in RTIs over time, or represented the level of economic development in individual provinces or cities. Moreover, a few previous studies had offered some data for Chinese road traffic safety trends and disparities in road traffic mortality based on sociodemographic factors, geographical regions, and types of road user used police-reported data from 1985 to 2005 and from 1951 to 2008 (8, 9). The injury rate and mortality rate of traffic accidents increased duo to the rapid development of China's economy and from 1996 to 2015, the motorization rate showed rapid growth, increasing from 0.023 to 0.188 (/Person) (10). It still lacks adequate data about traffic accidents in the different level of economic development. Thus, it is necessary to show these details in the RTIs research.

China, has various regional differences, in the East, Centre and West of economic development. When using the gross domestic product (GDP) per capita data to construct the Theil Index 1978 to 2016 and found that the Theil Index of the eastern economic development level is negative, while the Theil Index of the economic development level of the central and western regions is in a state of decline (11). Between 2011 and 2015, of the top five provinces and municipalities with a total GDP ranking, the first four provinces are located in the eastern region. In contrast, only one province in the western region ranked in the top 15 (12). Given the previously established links between certain social determinants of health (SDH model), such as regional economy, regional economic development differences may affect regional RTIs.

In this study, we aimed to test the hypothesis that the area difference of RTIs in East, Middle and West are caused by unequal economic development in China. We also try to clearly describe the epidemiological characteristics of RTIs thus

providing theoretical guidance for their prevention to reduce RTIs in different areas in China.

## Methods

### *Data Source*

This longitudinal study was based on national data. The related data of RTIs were extracted from China National Bureau of Statistics (<http://www.stats.gov.cn/>). The data about car ownership were from China Statistical Yearbook Information Network (<http://www.tjcn.org/>). The data is updated every two years, so the latest year was 2017. In order to ensure the quality of the collected data, any duplicate or redundant information concerning the injuries was cleaned.

### *The Inclusion/Exclusion Criteria and Study Design*

The inclusion criteria were as follows:

The data should include the RTIs frequency, death toll, injured people, economic loss in West, Centre and East regions in China; The data should include the GDP and car ownership of China's eastern and central and western regions.

The excluding criteria, included data from more than six years ago as well as some main data were lost.

### *Definition of study variables*

- 1) Road traffic accident fatalities are defined to include all traffic-related deaths that occur within 7 days after the crash event.
- 2) GDP (Gross Domestic Product) is defined as the market value of all final products and services produced by all resident units in a country (within the borders of a country) within a certain period of time.
- 3) Accident regions are classified into three groups: Eastern region (economically developed coastal areas), Western region (the less-developed interior areas), and Central region (the middle economies, between Eastern and Western regions).
- 4) According to the inclusion criteria of the traffic police departments around China, road

traffic accident categories are defined to include all traffic related crashes (motor vehicle traffic accidents, non-motor vehicle traffic accidents, pedestrian and passenger related traffic accidents, and the 'other' traffic category).

### Statistical Methods Data Analysis

A cross-sectional study combined with the time point tracking were used in our study. The effective data relative to the RTIs, car ownership, GDP were extracted by the official website. Epidemiological approach was used to conduct the analysis. Microsoft Office Excel (version 2007) and SPSS (version 18.0, IBM Corp., Armonk, NY, USA) were used for statistical analysis. Origin (version 9.0) was used for the graph. Pear-

son correlation coefficients ( $r$ ) were computed to analyze correlations between GDP and other continuous variables. The multiple linear regression analysis were also conducted. All tests were two-tailed, and a  $P$  value of  $< 0.05$  was considered as statistically significant.

### Results

As shown in Table 1 and 2, the data indicated the East was the highest in frequency of RTIs, injured people, death toll or economic losses caused by RTIs, followed by the Centre, the West was the last, except for the death toll from RTIs, the West was higher than the Centre instead.

**Table 1:** Characteristic of RTIs in the East, Centre and West in China

Characteristic	2012			2013			2014			2015		
	E*	C*	W*	E	C	W	E	C	W	E	C	W
Traffic accident frequency	103298	54360	46538	101428	52480	45053	100861	50484	44900	96434	47821	43526
Injured people	107240	62392	54695	103396	58617	51711	105108	55880	50894	98369	52534	48977
Death toll	29386	14378	16233	28691	13972	15876	27928	13800	16795	27758	13820	16444
Economic loss <sup>#</sup>	4.92	4.28	2.55	4.61	3.48	2.29	4.57	3.67	2.52	4.13	3.79	2.45

\*E = East, C = Centre, W = West; <sup>#</sup>Economic loss: billion RMB (numbers are rounded off)

**Table 2:** Continued: Characteristic of RTIs in the East, Centre and West in China

Continued Characteristic	2016			2017			Total		
	E	C	W	E	C	W	E	C	W
Traffic accident frequency	96605	62223	54018	93163	64439	55447	591789	321807	289482
Injured people	96530	66563	63337	89968	56783	62903	600611	352769	332517
Death toll	27821	17900	17372	27301	18096	18375	168885	91966	101095
Economic loss	4.45	4.49	3.14	4.54	4.19	3.40	27.22	23.90	16.35

Among the frequency of RTIs in the different types, car traffic accidents accounted for the larg-

est proportion, up to 75.95% followed by motorcycles of 21.67%. Pedestrian ride accounted for

1.35%. Tractor accounted for the smallest proportion, as 1.03% in China in 2017 (Fig. 1a). As for the number of injured people, their proportions were 73.72%, 24.63%, 0.94% and 0.71%, respectively (Fig. 1b). While among the death toll, their proportions were 78.11%, 18.34%, 2.21% and 0.71%, respectively (Fig. 1c).

and 1.34%, respectively (Fig. 1c). For the direct economic losses, their proportions were 89.44%, 8.44%, 1.51% and 0.61% for car traffic accidents, motorcycles, pedestrian ride and tractor, respectively (Fig. 1d).

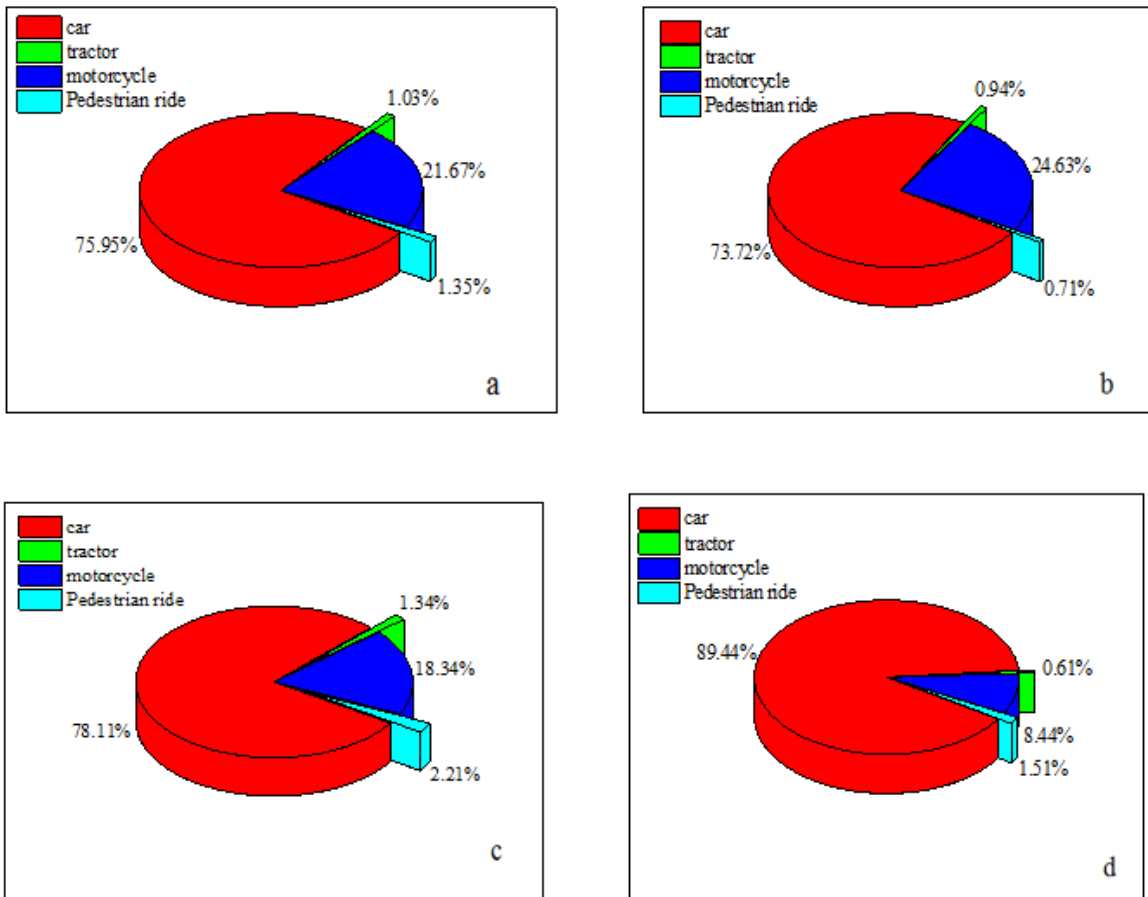


Fig. 1: Composition ratio of different types of RTI in different characters. a. Frequency; b. Injured people; c. Death toll; d. Economic losses

Taken together, our data demonstrated that among different types of RTIs, the frequency of traffic accidents, injured people, death toll, car traffic accidents accounted for the largest proportion. From the perspective of direct economic losses, the consequences of car traffic accidents were even more serious. The second most serious was motorcycles, followed pedestrian ride and tractors.

Fig. 2 shows the GDP differences in the East, Centre, and West from 2012 to 2017. The GDP of China in East, Centre and West was all slowly rising. The eastern part of China was the most economically developed, the central part was the second, and the western part was relatively backward.

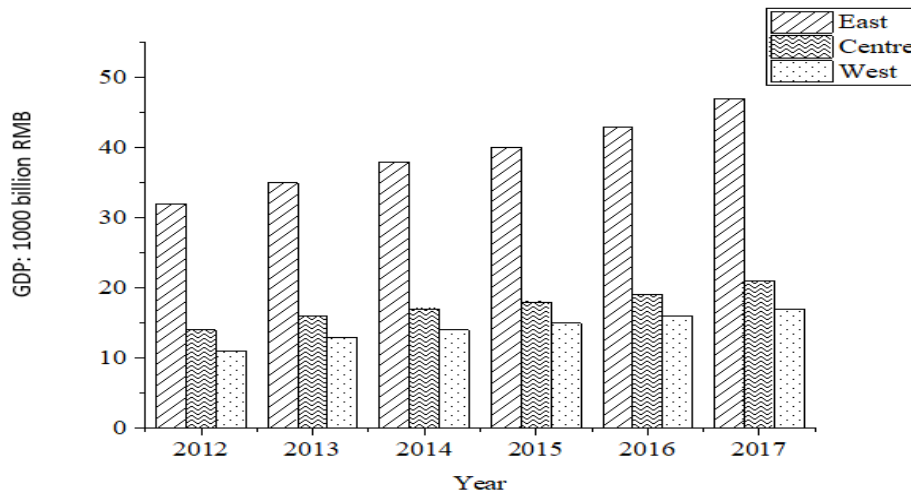


Fig. 2: Comparison of GDP in East, Centre and West in China

We conducted a multiple correlation analysis of car ownership and RTI frequency, injured people, death toll, GDP (Table 3). In Table 3 the minimum value of correlation coefficient between independent variables and death toll was 0.84, which indicated that the above four factors had

significant correlation with death toll. A multiple linear correlation and regression model was built to assess the correlation coefficient and determination coefficient between the above factors and dependent variables—death toll (Table 4).

Table 3: Correlation coefficient of car ownership and RTIs frequency, injured people, death toll, GDP

<i>Independent variables</i>	<i>Correlation coefficient related to Car ownership</i>	<i>P-value</i>
RTIs frequency	0.87	0.002
Injured people	0.84	0.004
Death toll	0.87	0.002
GDP*	0.97	0.001

\*GDP: Gross Domestic Product

Table 4: The multivariate linear regression of death toll and RTIs, frequency, car ownership, GDP

<i>Variable</i>	<i>Coefficient</i>	<i>Standard error</i>	<i>Value of t</i>	<i>P-value</i>
Constant	-4320.610	1700.329	-2.541	0.052
RTIs frequency	0.673	0.087	7.775	0.001
Car ownership	0.001	0.000	5.613	0.002
GDP*	-0.247	0.045	-5.457	0.003

\*GDP: Gross Domestic Product

$$Y = -4320.610 + 0.673X_1 + 0.001X_2 - 0.247X_3 + e$$

In the regression model, Y was death toll, X<sub>1</sub> was RTIs frequency, X<sub>2</sub> was Car ownership, X<sub>3</sub> was GDP, e was residual

Through the stepwise selection method in multiple regression, after eliminating the meaningless variables, the number of injured people. Then we built multiple regression equation including, RTIs frequency, car ownership, GDP. In addition, the determination coefficients of the regression model were  $R^2=0.99$   $F=169.956$ ,  $P < 0.001$ , which indicated that the regression model was well fitted. The establishment of regression equations makes sense. The coefficient of each factor is shown in Table 4.

$$Y = -4320.610 + 0.673X_1 + 0.001X_2 - 0.247X_3 + e$$

In the regression model, Y was death toll,  $X_1$  was RTI frequency,  $X_2$  was car ownership,  $X_3$  was GDP, e was residual.

This showed that with the increase of RTI frequency, car ownership, the death toll has increased, while with the increase of GDP, death toll has decreased.

## Discussion

China's previous studies had mainly described the changes in RTIs over time, or represented the level of economic development in individual provinces or cities. Our research firstly combines the years, regions, and regions of GDP to explain the characteristics of RTIs in East, Centre, and West, which included and compared the economically developed or underdeveloped areas in China.

The present study about RTIs showed that all of the frequency of RTIs, injured people, and economic losses were the highest in the East, followed by the Centre, and the lowest was in the West. Moreover, the mortality rate in the East was the highest, following by the West. In the meantime, eastern GDP was much higher than the central and western regions. We tentatively put forward that there are more traffic accidents, more injuries and more economic losses in economically developed areas than in economically backward areas. The differences of RTI's characteristics between the East, Centre and West were caused by the unequal of regional development. In additional, the result also showed that regard-

less of the frequency of traffic accidents, the number of injuries, the number of deaths, economic losses, the car accounted for the majority of the proportion. Our results are in agreement with the following two previous studies, one reported that areas with more rapid economic growth such as Guangdong, Zhejiang, and Jiangsu provinces reported more traffic injuries compared with less developed regions or regions with established development (9). RTIs were caused mostly by motor vehicles, mainly passenger cars, motorcycles (13).

There are various reasons why RTIs in the East are far more severe than the Centre and Western regions, more importantly, the high GDP in the east means that people are capable of buying cars and demands for cars are higher than those in the Central and Western regions. Through correlation analysis, it was concluded that the car ownership was positively associated with the traffic occurrence. With the more developed economy, more motor vehicles, the density of vehicles travelling on the roads is much higher than that in the Central and Western economically underdeveloped regions, and the possibility of traffic accidents greatly increased (14). The reasons why there are fewer traffic accidents injury but the serious deaths in the West region has aroused our interests. The following reasons can be used to explain this phenomenon. First and foremost, the western region is mainly composed of mountain roads and the roads are circling, narrow and winding. The terrain is dangerous and the roads condition are complex (15). Furthermore, road facilities and traffic signs are unsatisfactory, drivers cannot correctly judge the road situation, resulting in untimely disposal, causing heavy traffic damage such as crashes. Last but not least, there are many highlands and mountainous areas in the West, insufficient traffic safety and security facilities often lead to accidents without timely rescue, resulting in casualties and exacerbating the severity of traffic accidents (16). Lacking of emergency medical service is an important factor leading to poor outcomes in RTIs injury victims (17). The western economy is backward, the medical emergency capacity is even worse, and the network are



scattered. The ambulance cannot be as timely as the East. The complex terrain in the west, the regional differences in the allocation of medical resources and the backwardness of the western economy have led to severe RTIs, which has affected the health level of the people in the western region. This is consistent with that in the social determinants of health, region and the unfairness of medical resources and economic level affect the residents' health.

The results suggested that when formulating policies, the relevant departments should take into account the regional differences in RTIs. For the eastern region, the government should not only strengthen the scientific management of road traffic, but also promote traffic safety management, publicity and education. Using broadcasts, TV, newspapers, journals, and other mass media, active propaganda about traffic safety has been continuously put forward, thus improving all people's safety consciousness (18). The use of public transport has significantly reduced the incidence of traffic accidents (15). So the government should also promote the use of public transport. People should improve their awareness of road traffic safety and consciously abide by traffic rules, and traffic safety violations by drivers should also be strictly punished.

For the western region, the government except for drawing on some precautionary measures to reduce traffic accidents as in the East. The western governments should also strengthen road construction, improve road conditions, increase the intensity of highway security construction, and raise the level of post-treatment of traffic accidents. Strengthen and promote the medical treatment system of medical and police medical treatment before hospital, make the traffic injured people got professional and standard medical treatment as soon as possible, thus reduce the death rate and disability rate of RTIs. To the best of our knowledge, motor vehicles play an important role in traffic accidents, especially cars. In response to this, we should not only attach importance to safety education for automobile drivers, but also enhance the safety technical inspec-

tion of motor vehicles and improve the safety performance of motor vehicles.

In China, Healthy China 2030, puts health at the center of the country's entire policy-making machinery, making the need to include health in all policies an official government policy (19), which means that from the perspective of social determinants of health (SDH model), the eastern, central and western regions should focus on adopting differentiated policies and measures to improve residents' health and reduce RTIs, health inequality.

There are some limitations about the study. The research on traffic accidents lie in the lack of in-depth analysis of the specific causes of traffic accidents, such as drivers napping while driving, drunk driving, exceeding the speed limit, and illegal driving. At present, there is no official nationwide record about the reason of car accidents in China. Most of them are only recorded in some cities or provinces. In the future, we should do a better job in the level of the causes of automobile accidents, and provide preventive guidance for the occurrence of automobile accidents.

## **Conclusion**

RTIs has become a significant population health problem in China. Further efforts to reduce RTIs is warranted. The government should focus on preventing high traffic accidents in the East and high death tolls in the West.

## **Ethical considerations**

Ethical issues (Including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors. The data were collected from the official authoritative website and this article does not contain any studies with human or animal, formal consent is not applicable and required.

## Acknowledgements

This work was supported by the National Natural Science Foundation of China under Grant [Grant No.82060602, 81560534].

## Conflict of interest

The authors declare that there are no conflicts of interests.

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