Chinese Journal of Traumatology 24 (2021) 34–38

Contents lists available at ScienceDirect

Chinese Journal of Traumatology

journal homepage: http://www.elsevier.com/locate/CJTEE

Original Article

Influence of road types on road traffic accidents in northern Guizhou Province, China

Tian-Jing Sun, Si-Jia Liu, Fang-Ke Xie, Xiao-Fei Huang, Jian-Xiu Tao, Yuan-Lan Lu, Tian-Xi Zhang, An-Yong Yu*

Department of Emergency, the Affiliated Hospital of Zunyi Medical University, Guiyang, 563003, China

ARTICLE INFO

Article history:
Received 4 June 2020
Received in revised form
13 September 2020
Accepted 20 October 2020
Available online 19 November 2020

Keywords:
Road traffic accidence
Road types
Treatment
Injury prevention

ABSTRACT

Purpose: The increasing number of deaths due to road traffic accidents (RTAs) has attracted global attention. However, the influence of road types is rarely considered in the study of RTAs. This study evaluates the influence of different road types in RTAs in northern Guizhou to provide a basis for the formulation of evidence-based policies and measures.

Methods: We obtained the data from the Zunyi Traffic Management Data Platform for the years 2009–2018. The mortality rates of RTAs were calculated. Descriptive methods and Chi-square tests were used to analyze the characteristics of road traffic collisions on different road types. We also examined the associations between the mortality rate per 10,000 vehicles and the growth of per capital gross domestic product (GDP) with Spearman's rank correlation analysis. According to the passing volume and the infrastructure, we defined different types of roads, like administrative road, functional road, general urban road and urban expressway.

Results: In 2012, the traffic mortality rate of administrative roads was 8.9 per 100,000 people, and the mortality rate of functional roads was 7.4 per 100,000 people, which decreased in 2018 to 6.1 deaths per 100,000 people and 5.2 deaths per 100,000 people, respectively. The mortality rate per 10,000 vehicles reached the highest level in 2011 (28.8 per 10,000 vehicles and 22.5 per 10,000 vehicles on administrative and functional roads, respectively). The death rate of county roads was the highest among administrative roads ($\chi^2 = 17.389$, $p < 0.05$) and that of fourth-class roads was the highest among functional roads ($\chi^2 = 21.785$, $p < 0.05$). The mortality rate per 10,000 vehicles was negatively correlated with per capital GDP.

Conclusion: Although our research shows that RTAs in northern Guizhou have steadily declined in recent years, the range of decline is relatively small. Many measures and sustainable efforts are needed to control road traffic death and accelerate the progress in road traffic safety in northern Guizhou.

Introduction

Road traffic accidents (RTAs) have threatened the global public health and become the eighth leading cause of death among human beings. It is predicted that RTAs will rise to the fifth leading cause of death by 2030.[1] Although RTAs are decreasing year by year in developed countries, they are rising in developing countries. Several studies have predicted that road traffic injuries will have declined 27% in developed countries between 2000 and 2020, while those in undeveloped countries will have increased 83%.[2] On the occasion of the Global Decade of Action for Road Safety, all countries are to spare no effort to reduce RTAs and death by formulating better road traffic laws and regulations and improving RTA data collection, especially Brazil, Cambodia, China, Egypt, India, Kenya, Mexico, Russia and other low- and middle-income countries, the road traffic fatalities of which account for nearly half of all such fatalities in the world.[3,4]

China is the most populous middle-income country in the world. Since the reformation and opening-up of China, the annual per capita income has increased by 8.7% and the per capita national income reached 8260 US dollars in 2016.[1] This development of economy is bound to promote motorization and urbanization, which leads to the rapid growth of the automobile market and an increase of car ownership and makes road traffic injuries a serious threat to human health.[5,6] The number of motor vehicles increased

* Corresponding author.
E-mail address: anyongyu750811@126.com (A.-Y. Yu).
Peer review under responsibility of Chinese Medical Association.

https://doi.org/10.1016/j.cjtee.2020.11.002

from 3 million in 2000 to 186 million in 2009, and is estimated to increase to be at least 250 million by 2020. The number of RTAs increased from 55,437 in 1970 to 300,000 in 2016. The rapid development of the social economy and the continuous increase of car ownership have a great impact on the highway construction. From 2001 to 2007, the highway mileage in China rose from 19,500 km to 53,000 km and reached 143,000 km by 2018, which surpasses the mileage of all developed countries and ranks first in the world.

The surge of vehicles and the expansion of road networks have had a profound impact on road traffic injuries in China. It was reported that 75% of road traffic deaths and fatal injuries in China occurred in mountainous areas in 2007–2013.[7] Guizhou is the only province in China without plains and is surrounded by endless mountains. Traffic has always been regarded as a major bottleneck in the province's economic and social development. The northern part of Guizhou is an important transportation hub in southwest China, 92.5% of which is covered by complex and steep terrain: mainly plateaus, mountains, hills and basins. Compared with that of other developed cities in China, the topography of northern Guizhou is complex. However, Guizhou was the first region in China to build an interchange highway from county to county. With the social and economic development of northern Guizhou, road mileage increased from 21,800 km in 2009 to 32,942 km in 2017, and motor vehicle ownership increased from 364,200 in 2009 to 1.29 million in 2018.[8] Relevant research by Baru et al.[9] has shown that to reduce the unnecessary loss of life from RTAs, the county urgently needs to take pragmatic road safety intervention measures. To date, traffic accidents by road types are seldom reported. This paper conducts an analysis of correlation between road types and road conditions in RTAs in northern Guizhou to understand the influence of road types on RTAs and provide a basis for the formulation of evidence-based policies and measures in underdeveloped regions.

Methods

Data collection

We obtained data from the Traffic Management Data Platform in Zunyi, Guizhou Province, China. This system is maintained by the Zunyi Road Traffic Administration Bureau and collects road traffic collision data from all urban and rural areas in northern Guizhou. All deaths were reported and confirmed according to a quality control protocol.

Definition of study variables

We obtained the injury and death rates of motor vehicle traffic collisions. In China, roads are assigned different grades based on their main uses.[10] The definition of road types are below:

Functional roads

(1) Highways are the roads where cars are driven at high speed in separated lanes, and entry and exit are controlled for all vehicles. They are the skeleton of the national trunk highway system. The average passing volume of cars is more than 25,000 per day and night.
(2) First-class roads are for vehicles to be driven in separated lanes, and entry and exit are controlled for some vehicles. First-class roads are national trunk roads, and the annual average traffic volume is between 15,000 and 55,000 per day and night. Motorcycles and tricycles are prohibited from using these roads.
(3) Second-roads are also national trunk highways, but they are suitable for all kinds of vehicles, with an average annual traffic volume of 3000 to 7500 vehicles per day and night.
(4) Third-class roads are general trunk roads connecting counties, cities and towns above the county level, with an average annual traffic volume of 1000 to 4000 vehicles per day and night.
(5) Fourth-class roads are branch roads connecting counties, townships and villages, and their annual average traffic is the lowest. Of the functional roads, second-, third- and fourth-class highways are suitable for all kinds of vehicles.

Administrative roads

(1) National roads refer to the main trunk highways with national political and economic significance.
(2) Provincial roads refer to roads that have political and economic significance for the whole province.
(3) County roads refer to roads that have political and economic significance for the whole county and connect counties and the main townships\towns in the counties.
(4) Township roads connect townships and rural areas. They are divided into highways, expressways and ordinary highways based on speed.

Urban expressway

Urban expressway is the main expressway, with a central separation line and four lanes going in two directions. It uses all or part of the three-dimensional intersections and control channels to help vehicles increase speed. The main function of the urban expressway is to ensure the smooth flow of cars, maintain uninterrupted driving, and improve traffic in the city. The driving speed is 60–100 km/h.

Urban general road

Urban general road refers to all urban roads except expressways, including trunk roads, secondary trunk roads and branch roads. The driving speed is 40–60 km/h.

Statistical analysis

We calculated the annual mortality rates of road traffic collisions during the study period of 2009–2018 and used both the total population and the number of registered vehicles as the denominators. We also used annual percentage changes and 95% confidence intervals (*CI*) for each distinct period to verify the estimates and test the significance. The deaths on functional grade roads, administrative grade roads, urban expressways, and urban general roads were analyzed using Chi-square tests to assess the significance of the change in mortality during the study period. The estimated model for deaths due to RTAs in relation to per capital gross domestic product (GDP) and the number of registered vehicles were $Y = 36.06-0.00063X$ and $Y = 26.30-0.00043X$ on administrative roads and functional roads, respectively. The coefficients were statistically significant ($p < 0.05$), and the coefficients of determination were 0.884 and 0.779, indicating a high goodness of model fit.

The statistical analyses were performed using statistical product and service solutions version 23.0. Differences were judged significant based on the two-tailed test if p values were less than 0.05. We also examined the associations between the mortality per 10,000 vehicles and the growth per capital GDP with Spearman's rank correlation analysis in Graphpad 8.0.

Results

Among the different road types, the death rate from RTAs on administrative roads is the largest, followed by that on functional roads (Table 1). Among the administrative grade, there are the most RTAs and deaths on county roads ($\chi^2 = 17.389$, $p < 0.05$) (Table 2), while there are the fewest number of traffic deaths on township roads. In 2012, the crude road traffic mortality rate for administrative roads was 8.9 per 100,000 population, which decreased in 2018 to 6.1 per 100,000 populations (95% *CI*: 6.045–7.815), and the mortality rate per 10,000 vehicles reached the highest level in 2011 (28.8 per 10,000 vehicles (95% *CI*: 11.72–23.64)) (Fig. 1A).

Of the functional grade roads, the largest number of RTAs and deaths occurred on fourth-class roads ($\chi^2 = 21.785$, $p < 0.05$) (Table 3). In 2012, the functional road traffic mortality rate was 7.4 per 100,000 populations, which decreased in 2018 to 5.2 per 100,000 (95% *CI*: 4.733–6.647), and the mortality rate per 10,000 vehicles reached the highest in 2011 (22.5 per 10,000 vehicles 95% *CI*: 9.668–18.21) (Fig. 1B). The data of highway traffic accidents began to be recorded in 2011, which gradually increased, and then decreased beginning in 2014. First-class highways have the least number of RTAs among all the functional grade roads.

The incidence of traffic accidents on urban general roads is 11.6 times higher than that on urban expressways. The number of RTAs on urban expressways is the lowest among on all roads. As the economy is increasingly improving, the death rate of per 10,000 vehicles is decreasing. The mortality rate per 10,000 vehicles was negatively correlated with per capital GDP. The estimated model for deaths due to RTAs in relation to per capital GDP and the number of registered vehicles was $Y = 36.06-0.00063X$ and $Y = 26.30-0.00043X$ on administrative roads and functional roads, respectively (Fig. 2).

Discussion

We analyzed the RTAs that occurred on different road types between 2009 and 2018, and reached several conclusions. First, there has been a downward trend in the number of deaths caused by RTAs regardless of the type of road after 2016. Second, of the functional roads, the RTA rate on first-class roads is the lowest, while the accident rate on fourth-class roads is the highest at the end of 10 years with the most deaths. Third, of the administrative roads, county roads have the highest number of RTAs and deaths, while township roads have the least number of RTAs. Fourth, the RTA rate of urban general roads is obviously higher than that of urban expressways.

Our results show that road types play an important role in RTAs. The higher the grade of the functional road is, the fewer RTAs occur and the fewer deaths are caused by RTAs. This is closely related to the topography of northern Guizhou. The terrain of northern Guizhou is dangerous and mountainous, and roads are often winding or shuttle between mountains and rivers, which makes the driving environment complex. Especially on second-, third- and fourth-class roads, traffic accidents are more frequent than on highways and first-class roads. Although the day and night traffic volumes of highways and first-class roads are much larger than those of other grades of roads, they have more complete safety measures and a higher quality monitoring system with limited speed and radars, that restrict the number of vehicles entering the highway. In addition, strict law enforcement and the extensive driving experience required to use these roads make the rate of RTAs on highways lower than that on other roads. Roads below the first-class allow all kinds of vehicles to be driven and have no requirements for driving experience, relatively low road quality and insufficient preventive road safety measures. Meanwhile, many vulnerable road users are not aware of road safety issues, and many drivers do not obey traffic rules. It is worth noting that there are some missing data on RTAs in highway and first-class road, which is related to the regional economic development and the construction of highway and first-class road arisen after 2010.

The national road and provincial road are the main trunk roads of the country and province, both with a larger volume of traffic. These roads are of great significance in the economic development and the exchange of cultural information in the province. However, the quality and environment of the county and township roads are low, and there are many road intersections. Thus, more RTAs are on county and township roads than on national and provincial roads. This is different from Liang et al.'s research in Suzhou, Anhui Province, which shows that the national and provincial roads have the most RTAs.[11] Rural roads mainly link townships with weak economic conditions and relatively few vehicles. In addition, China has made a great effort to develop rural construction in recent years, and the quality and environment of rural roads have been further improved. As a result, there are fewer RTAs on rural roads than on other administrative roads.

The RTA rate of general urban roads is obviously higher than that of urban expressways. This is consistent with Liang et al.'s findings.[11] In the process of the rapid development of motorization in the past few decades, the design of urban roads has mainly served motor vehicles, but the traffic safety of vulnerable people has not received enough attention in the process of urban motorization. In addition, with the rapid urbanization of rural areas, the urban population is increasing, and cities are becoming regional economic, cultural and information collection centers, with dense traffic and a complex traffic environment.

Although the economic level of northern Guizhou lags behind many cities in China, urbanization has led to a continuous increase in the urban population in recent years, which has inevitably led to an increase of urban motor vehicles and road congestion. However, urban roads are mainly designed for motor vehicles and not for motorcycles and bicycles, which is an important reason for the continuous increase in urban general RTAs in northern Guizhou.

Although the use of motor vehicles continues to increase due to the increasing growth of per capita GDP, the death rate per 10,000 vehicles on both administrative and functional roads is gradually decreasing. This shows that following the implementation of traffic laws and regulations, the death rate per 10,000 vehicles has not increased with the continuous increase in motor vehicles, which may be related to improvements in vehicle safety. The death rate per 10,000 vehicles of functional roads is lower than that of administrative roads, but when per capita GDP is approximately 50,000 RMB, the mortality rates per 10,000 vehicles of the two types of roads are more similar. Hence, deaths caused by vehicles of administrative roads are under control to a certain extent.

Generally, the number of RTAs and deaths in northern Guizhou has steadily declined, which is closely related to the improved awareness of road safety. There are three stages in the development of road traffic safety: primary, intermediate and advanced. In the initial stage of motorization, people do not understand the risks accompanying by high-speed motorized traffic vehicles and have no awareness of the need to follow traffic rules. In the intermediate

Table 1
Frequency of road traffic accidents on different road types in northern Guizhou.

Road types	Accidents	Injuries	Deaths	Mortality rate (%)
Administrative road	13,494	19,540	5472	21.9
Functional road	11,010	16,038	4466	21.8
Urban general road	3319	3858	915	19.2
Urban expressway	287	322	111	25.6

Table 2
Frequency of road traffic accidents in administrative road in northern Guizhou.

Year	National road			Provincial road			County road			Township road			Mortality rate	
	Accidents	Injuries	Deaths	Accidents	Injuries	Deaths	Accidents	Injuries	Deaths	Accidents	Injuries	Deaths	a	b
2009	164	267	68	176	287	76	361	483	127	324	486	112	5.1	28.0
2010	29	26	23	230	335	101	339	485	131	322	490	120	4.9	21.5
2011	195	290	83	375	619	170	394	556	162	288	395	108	6.8	28.8
2012	301	498	157	422	621	220	453	655	192	281	408	124	8.9	26.1
2013	304	462	143	373	634	143	409	573	173	255	395	123	7.4	19.3
2014	379	608	178	440	665	131	429	637	172	288	380	130	7.7	16.5
2015	392	576	169	411	666	141	451	632	165	311	430	121	7.5	11.8
2016	419	531	191	360	501	139	467	665	172	286	387	115	7.6	9.8
2017	375	486	153	339	459	141	434	625	159	320	439	139	7.3	8.4
2018	324	424	130	299	409	102	464	638	150	311	417	119	6.1	6.6

a:deaths per 100,000 population, b:deaths per 10,000 vehicles.

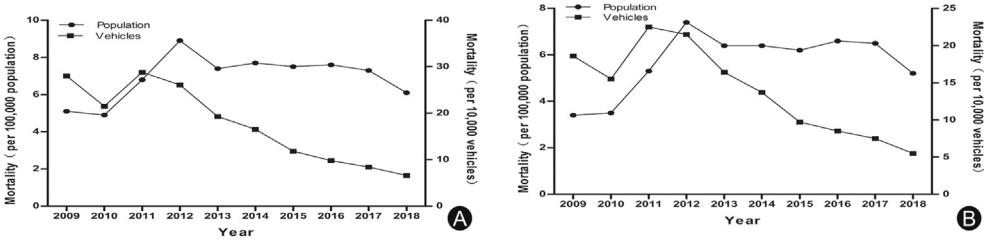

Fig. 1. The change of the mortality rates on administrative roads and functional roads. (A) The change of death rate per 100,000 population and per 10,000 vehicles on administrative roads. (B) The change of death rate per 100,000 population and per 10,000 vehicles on functional roads.

Table 3
Frequency of road traffic deaths on functional roads in northern Guizhou.

Year	Class level					Mortality rate	
	Highway	First	Second	Third	Fourth	a	b
2009	0	0	48	127	79	3.4	18.6
2010	0	0	45	124	102	3.5	15.5
2011	3	0	109	155	141	5.3	22.5
2012	83	2	196	129	159	7.4	21.5
2013	65	2	138	124	168	6.4	16.4
2014	78	0	122	134	171	6.4	13.7
2015	67	4	125	145	151	6.2	9.7
2016	83	7	112	160	170	6.6	8.5
2017	60	8	119	141	193	6.5	7.5
2018	48	6	103	119	141	5.2	5.5

a:deaths per 100,000 population, b:deaths per 10,000 vehicles.

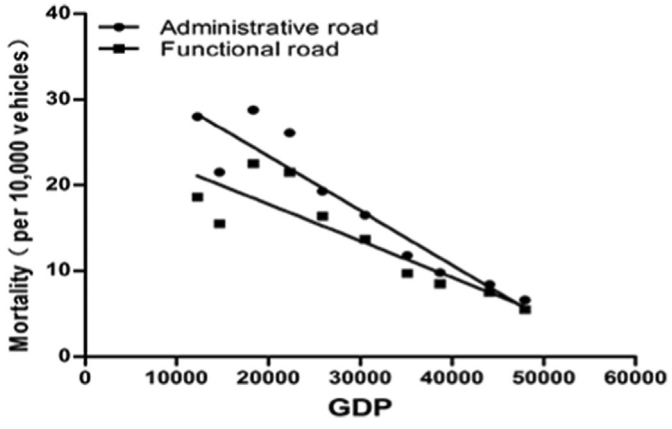

Fig. 2. The relationship between gross domestic product and the deaths rate per 10,000 vehicles.

stage, people begin to pay attention to personal protection measures. In the advanced stage, being fully aware of the safety risks, people initiatively abide by traffic rules, laws and regulations. After experiencing these stages, people gradually realize the importance of road traffic safety for saving lives, coupled with an awareness of the increase in the number of deaths caused by global RTAs each year. All countries have spared no effort to formulate a variety of policies and regulations conducive to the reduction of RTAs. Traffic law enforcers need to strengthen both law enforcement against the five major risk factors (speeding, drunk driving, not using seat belts, not wearing helmets, and not using child safety seats) and road traffic safety publicity so that consciousness road traffic safety can be gradually rooted in the minds of the population. In addition, the development of high-speed railways is of great importance to reductions in the occurrence of RTAs. With the development of the economy and the acceleration of economic exchanges between provinces, high-speed railways between neighboring provinces have been constructed in northern Guizhou in recent years. People are willing to choose high-speed rail because it is faster, more economical and safer than motor vehicle driving.

The decline in the number of road traffic deaths is not only related to reductions in RTAs but is also closely related to medical conditions. Studies have shown that one of the most important causes of road traffic deaths is imperfection in the traffic injury response system. The lack of emergency medical teams and of related training for medical staff is one reason for the low success rate of pre-hospital rescue.[12] As a three-piece emergency medical treatment system, the perfect emergency medical service system should include pre-hospital, in-hospital, and critical intensive care, which would have reduced RTAs mortality.[13]

Road types have an important effect on RTAs in northern Guizhou. Road management should be strengthened, especially for roads below the level of first-class, administrative roads and general urban roads. First, a reasonable urban road safety system and environment should be designed. For example, flower beds that easily distract drivers should be replaced by barriers in the median

strip. In addition, the flower beds need to be trimmed and watered regularly, and having workers doing so is more likely to cause rear-end collisions. If flowers and plants must be planted in the middle, the height of traffic lights at intersections could be raised, which would prevent drivers from running a red light because of blind spots.

Second, in addition to improving the road monitoring system, we should also increase the use of traffic warning signs and strengthen the inspection of accident-prone roads. If there is a road traffic accident on the highway, especially at night, road traffic officers should request fluorescent warning signs to be placed by the accident to remind vehicles to slow down and change lanes. Furthermore, traffic law enforcement personnel should increase the penalties for illegal acts on the road, especially drunk driving and speeding, and improving the quality of education in driving schools should be strictly improved, which would also improve the driving level of new drivers. We should strengthen publicity for road safety to vulnerable groups (pedestrians, two-wheeled vehicles or electric vehicles) to reduce the occurrence of traffic accidents as much as possible. Moreover, it is necessary to continue to improve the emergency medical service system in northern Guizhou, shorten the response time of pre-hospital first aid, improve the skills of medical treatment and nursing staff, and train professional trauma rescue teams to reduce the deaths caused by RTAs as much as possible. A trauma database should be established as soon as possible. As described by Ecola et al.,[14] through implementing effective plans and policies, improving emergency response and trauma care, strengthening safety education and publicity, speeding up the development of driving assistance technology, and forming a new safety culture, zero death could be achieved on American roads by 2050. In addition, we should call on more people to adopt green travel modes and reduce the use of motor vehicles, which would not only reduce the incidence of RTAs but also improve people's health. A recent study has shown that in a rapidly developing city, an increase in vehicle ownership leads to reduced physical activity and weight gain. Increasing car use and ownership in developing countries may adversely affect health and obesity.[15]

Our study has some limitations. First, some information on relevant factors, such as road conditions (e.g. weather, road environment), age and circumstances surrounding the crashes (e.g. seatbelt, helmets and child restraint usage and drunk or fatigued driving) are not collected in the Zunyi Traffic Management Data System. If we want more detailed information, we have to obtain higher permissions. Second, although these data cover a wide range of roads and accidents, the results may be affected by misclassifications in Zunyi Traffic Management data. Third, there are some missing data on RTAs on highways and first-class roads, and thus an effort should be made to improve the validity of the road traffic injury data in northern Guizhou.

Our research shows that RTAs in northern Guizhou have steadily declined in recent years. We cannot recommend reducing the use of certain roads, because roads are important transportation hubs for people's travel and regional economic development, but we suggest people choose green travel and take high-speed rail to reduce the use of motor vehicles as much as possible. In addition, strict enforcement of traffic regulations is also an important measure to reduce RTAs, especially drunk driving and speeding. So, we suggest that road traffic management departments should strengthen the management and law enforcement, establish more effective detection systems and road signage for different road types, and improve road structures and quality, and increase law enforcement personnel especially on county roads and fourth-class roads. We suggest setting up bicycle and motorcycle lanes in general urban roads to avoid fatal traffic accidents caused by bicycles and motorcycles entering motor vehicle lanes. Road traffic data systems should be improved to better collect relevant data to establish better road traffic network. Last but not least, road traffic officers should increase traffic safety publicity to deeply root awareness of road safety in the hearts of the people.

Funding

The study was supported by the National Natural Science Foundation of China (NSFC No. 81760233) and Science and Technology Project of Guizhou Province (No.[2020]4Y149 and [2019]5661).

Ethical statement

Ethics approval was not required for this research.

Declaration of competing interest

There was no conflict of interest declared.

References

1. WHO. *Global Status Report on Road Safety 2018*. Geneva: WHO Press; 2018.
2. Shen YJ, Hermans E, Bao Q, et al. Serious injuries: an additional indicator to fatalities for road safety benchmarking. *J Traffic Inj Prev*. 2015;16:246–253. https://doi.org/10.1080/15389588.2014.930831.
3. Peden M, Di Pietro G. Saving lives by improving road safety. *J Public Health*. 2017:S3–S4. https://doi.org/10.1016/j.puhe.2016.12.038.
4. Bishai D, Hyder AA. Making measures matter in road safety: introduction to a special supplement. *J Public Health*. 2017:S1–S2. https://doi.org/10.1016/j.puhe.2016.12.039.
5. Wang J. Regulatory quandary and its solutions of internet chauffeured carin China. *Adm Law Rev*. 2016;2:49–59.
6. *WHO. World Report on Road Traffic Injury Prevention*. Geneva: WHO Press; 2004.
7. Chen YK, Li YM, Mark K, et al. Identification methods of key contributing factors in crashes with high numbers of fatalities and injuries in China. *J Traffic Inj Prev*. 2016;17:878–883. https://doi.org/10.1080/15389588.2016.1174774.
8. Zunyi Statistical Year Book. Transportation data. http://www.zunyi.gov.cn/zwgk/jcxxgk/tjxx/tjnj/201811/P020181127426059069693. Accessed July 6, 2019.
9. Baru A, Azazh A, Lemlem B. Injury severity levels and associated factors among road traffic collision victims referred to emergency departments of selected public hospitals in Addis Ababa, Ethiopia: the study based on the Haddon matrix. *J BMC Emerg Med*. 2019;19:2. https://doi.org/10.1186/s12873-018-0206-1.
10. https://baike.baidu.com/item/公路等级/5706463?fr=aladdin. Accessed August 27, 2019.
11. Liang MM, Zhang Y, Qu GB, et al. Epidemiology of fatal crashes in an underdeveloped city for the decade 2008-2017. *J Int J Inj Contr Saf Promot*. 2020;27:253–260. https://doi.org/10.1080/17457300.2020.1737140.
12. Wang TB, Yin XF, Zhang PX, et al. Road traffic injury and rescue system in China. *J Lancet*. 2015;385:1622. https://doi.org/10.1016/S0140-6736(15)60794-2.
13. Wang Y, Liu HX, Wang YH, et al. Establishment of trauma treatment teams within a regional severe trauma treatment system in China: study protocol for a national cluster-randomised trial. *J BMJ Open*. 2018;8, e023347. https://doi.org/10.1136/bmjopen-2018-023347.
14. Ecola L, Popper SW, Silberglitt R, et al. The road to zero: a vision for achieving zero roadway deaths by 2050. *J Rand Health Q*. 2018;8:11.
15. Anderson ML, Lu FW, Yang J. Physical activity and weight following car ownership in Beijing, China: quasi-experimental cross sectional study. *J BMJ*. 2019;367:l6491. https://doi.org/10.1136/bmj.l6491.