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Prevalence and regional correlates of road traffic injury among Chinese urban residents: A 21-city population-based study

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ABSTRACT

Objective: This study estimated the prevalence of road traffic injury among Chinese urban residents and examined individual and regional-level correlates.

Method: A cross-sectional multistage process was used to sample residents from 21 selected cities in China. Survey respondents reported their history of road traffic injury in the past 12 months through a community survey. Multilevel, multivariable logistic regression analysis was used to identify injury correlates.

Results: Based on a retrospective 12-month reporting window, road traffic injury prevalence among urban residents was 13.2%. Prevalence of road traffic injury, by type, was 8.7, 8.7, 8.5, and 7.7% in the automobile, bicycle, motorcycle, and pedestrian categories, respectively. Multilevel analysis showed that prevalence of road traffic injury was positively associated with minority status, income, and mental health disorder score at the individual level. Regionally, road traffic injury was associated with geographic location of residence and prevalence of mental health disorders.

Conclusions: Both individual and regional-level variables were associated with road traffic injury among Chinese urban residents, a finding whose implications transcend wholesale imported generic solutions. This descriptive research demonstrates an urgent need for longitudinal studies across China on risk and protective factors, in order to inform injury etiology, surveillance, prevention, treatment, and evaluation.

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Introduction

Injury is a serious public health problem with substantial social and economic costs. In 2013, 973 million people worldwide sustained injuries that warranted some type of health care, and 4.8 million people died from injuries (Haagsma et al. 2016). Between 1990 and 2013, global age-standardized injury disability-adjusted life years decreased by 31%. Road traffic injury (RTI) was the most common type of injury by external cause. In 2010, 1.24 million people were killed on the roads worldwide. This is an unacceptably high toll, with major adverse effects on families and communities, as well as on national economies (World Health Organization [WHO] 2013). Over 90% of world road fatalities occur in low-income and middle-income countries, countries that have less than half of all registered vehicles (WHO 2009). Rapid economic growth in China has been accompanied by a major increase in automobiles and vehicle miles traveled and, as a consequence, induced a large increase in related injuries. There was an 81% increase in the motor vehicle crash-related mortality rate between 1987 and 2001 (Peden et al. 2002).

There are 2 limitations impacting research on RTIs. First, prior studies of RTIs were mainly confined to crash or mortality data from traffic management departments, hospital-based surveillance, or population management systems (Chini et al. 2009; Garg and Hyder 2006; Rossi et al. 2005). Few included population survey data, especially from large-scale surveys (Robb et al. 2008; Verma and Tiwari 2004). None was Chinese. Population-based survey data can characterize prevalence of RTIs, assess risk factors, guide design and evaluation of interventions, inform policy makers and decision makers, raise public awareness, and help target safety programs for at-risk groups (WHO 2009). The second limitation is that, although many studies explored the underlying determinants of RTIs, most focused on individual-level correlates (Herman et al. 2012; Rossi et al. 2005). Little attention has been paid to identifying the relative impact of regional determinants (Poulos et al. 2007; Rivas-Ruiz et al. 2007). Compared to individual variables, regional variables yield more stable estimates of personal social environments. It is crucial to explore regional variants and influences in terms of understanding RTIs, especially from a public health and policy perspectives. Regional variation is plausibly a product of heterogeneous social, mental, and behavioral practices, as well as differential socioeconomic development. The Chinese mainland is vast, culturally diverse, and developmentally

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heterogeneous. By utilizing a national population sample, it was possible to accommodate such variability within the present study.

This study helps address the deficits in previous research, within the Chinese context, by estimating the prevalence of RTIs and identifying individual- and regional-level correlates among urban residents. Results will facilitate the design of prevention programs and provide needed evidence to policy makers for informing interventions to reduce both the national injury burden and its motor vehicle traffic crash component.

The first aim of this cross-sectional study was to estimate the prevalence of RTIs among urban residents, distinguishing automobile, bicycle, motorcycle, and pedestrian components. Prior studies have estimated the prevalence of RTIs to be high among this population (Li and Baker 1991; WHO 2009). The second aim was to identify individual- and regional-level correlates. This study emphasized socioeconomic status and mental health. We examined socioeconomic status and RTI at both individual and regional levels, to take into account individual safety awareness and behavior and environmental factors that impact traffic safety (Yang 2007). Many studies have found an association between socioeconomic status and RTI at the individual level (Cubbin and Smith 2002; Nantulya and Reich 2003) and a few at the regional level (Rivas-Ruiz et al. 2007; Tian et al. 2013; Yongchaitrakul et al. 2012). Mental health is a key determinant of RTIs (Blanchard and Veazy 2001; Wan et al. 2006; Williams and Andersen 1998). It is plausible that severe motor vehicle trauma can induce mental disorders (Blanchard and Veazy 2001; Koren et al. 1999), but it remains unclear how this association impacts the general population (Garg and Hyder 2006). However, people with mental health disorders are at excess risk for RTIs (Wan et al. 2006; Williams and Andersen 1998). No attention has been given to the impact of variation in regional-level mental stress on the prevalence of RTIs, independent of individual-level factors. We also examined the association between mental health and RTIs at both levels of analysis.

Methods

Setting and subjects

This study employed a cross-sectional, multistage sampling design. In stage 1, 21 Chinese cities were selected according to geographic region. Nine are located in the east, 6 in the central region, and 6 in the west. Stage 2 was the selection of residential districts within each city. Two residential districts with a high density of family households were randomly selected from the sampling frame in each study city. In stage 3, 4 communities were randomly selected within each residential district. In stage 4, a family household registration (*hukou*) list was used to randomly sample households in each community. We contacted community organizations, from whom we obtained a family household registration list. Then, with their assistance, we visited each potential subject's home.

Individuals aged 15 years and older who were permanent residents and had resided in their home for at least a year were identified within each household. Finally, one potential subject was randomly selected from each family, with eligibility being determined by the birth date closest to the contact date (Yang et al. 2015). Approximately 100 potential subjects were included in the survey in each community. They were informed about the purpose of the survey, and consent for participation was obtained in a face-to-face meeting.

Data collection

The study was approved by the Ethics Committee at the Medical Center, Zhejiang University. Research staff scheduled an appointment for administration of a personal written questionnaire once an eligible urban resident was identified and consented to participate and an interview was scheduled. Questionnaires were administered by fourth-year medical students (approximately 10 per city), who had received a one-day training on the study protocol and survey procedures. Respondents completed the questionnaire in the privacy of their own homes or in a designated quiet place, after receipt of oral instructions by staff about both the questionnaire and the survey purpose. Completion took approximately 30 min. A staff member read through the entire questionnaire to those respondents with low education and/or physical limitations. Each respondent was afforded an opportunity to seek clarification from the staff about the questionnaire or survey, given adequate time for questionnaire completion, and rendered extra assistance as necessary. A uniform research protocol was employed across the 21 cities to assure homogeneity of data collection.

Measures

Dependent variable

Survey respondents were asked to report on any injury they had sustained during the prior year in a motor vehicle crash as a driver or passenger (1) in an automobile (car, truck, or bus), (2) on a bicycle, (3) on a motorized scooter or motorcycle, and/or (4) as a pedestrian. A reportable injury was defined as any injury satisfying one or more of the following criteria: resulted in treatment (1) by a physician, (2) as an emergency department visitor (3) or hospital inpatient or in the need (4) to recuperate for a half day or longer (Koziol-McLain et al. 2000; Yang et al. 2015). The dependent variables all pertained to RTIs, distinguished by type as automobile, bicycle, motorcycle, and pedestrian. They were coded dichotomously as 1 = injured and 0 = not injured.

Individual-level independent variables

The questionnaire tapped the following sociodemographic characteristics: Age, gender, ethnicity, educational attainment, occupation, and annual average household income. The Chinese Health Questionnaire (CHQ) was used to screen for mental health disorders. Based on the General Health Questionnaire, the CHQ is employed for screenings in community settings (Yang et al. 2003) and has been commonly used as a research tool in community and primary care settings in China (Ma et al. 2007; Yang et al. 2003). It is a self-administered, 12-item instrument designed for detecting mental health disorders within the community and among primary care patients. The 4 alternative response options were reduced to a dichotomous outcome: (1) *not at all* and *same as usual* = 0, and (2) *rather more than usual* and *much more than usual* = 1 (Goldberg and Williams

1991; Yang et al. 2003). The severity of mental health disorders on the CHQ was assessed by summing the scores on the 12 individual items. A cutoff score of 3 or higher on the CHQ signified a mental health disorder (Goldberg and Williams 1991; Yang et al. 2003).

Regional-level independent variables

This study utilized several regional-level independent variables to represent different aspects of the research domain across the 21 study cities. They were chosen with consideration of regional location of residences of the study population and associated socioeconomic and mental health characteristics. Information on location and socioeconomic status was accessed through a national database, and mental health characteristics were based on aggregated individual-level responses. Geographic region was categorized as northeast, central and northwest, southeast, south, and southwest according to conventional divisions used by the National Bureau of Statistics (Department of Comprehensive Statistics of National Bureau of Statistics 2012). Geographic differences can reflect heterogeneity in socioeconomic development, cultural norms relating to RTI, and behavior. The Chinese mainland is vast and culturally and developmentally diverse. Socioeconomic status is a basic determinant of RTIs (Cubbin and Smith 2002; Nantulya and Reich 2003). Regional socioeconomic variation was represented by per capita gross domestic product and differentiated as less than 40,000, 40,000–49,999, and 50,000 or more yuan. The data were obtained from the National Bureau of Statistics (Department of Urban Social Economic Survey of the National Bureau of Statistics 2012). Mental health was a key variable in this study. Regional mental health was differentiated according to prevalence of mental health disorders in the population: Less than 15%, 15–19%, and 20% or higher.

Data analysis

Descriptive statistics were calculated on the prevalence of RTIs. We use a map to show the geographic distribution of RTI prevalence in China. The primary statistical analysis involved use of the chi-square test to determine differences in prevalence across selected regional and individual-level variables using the SAS 9.3 survey procedure (Goldstein 1995). Associations were assessed through application of a multilevel, multivariable logistic regression model using an SAS NLMIXED procedure (Grilli and Pratesi 2004). Odds ratios (ORs) and associated 95% confidence intervals (CIs) were used to estimate the magnitude of associations. A nested hierarchical multilevel modeling technique has substantial advantages over a single-level regression procedure, when there is both a defined outcome measure and clear differentiation of individual and place, as in this study. Ecologic and atomistic fallacies were precluded by modeling random variation at both individual and regional levels (different cities), thus providing the capacity to differentiate individual and contextual effects upon RTI outcomes (Grilli and Pratesi 2004).

We utilized 2 models. We started with the null model, a 2-level model with random intercepts. This model only included a constant in accounting for variation in RTI across the 21 study cities. In this base model, we entered all individual- and regional-level variables as fixed main effects, which were significantly associated with RTIs in chi-square analyses, to form the full model for evaluating the impact of all variables on RTIs. Model fitting was assessed by the likelihood of a change in the −2 log. Significance of the random parameter variance estimates was assessed using Wald's joint χ^2 test statistic (Goldstein 1995).

All analyses were weighted (Grilli and Pratesi 2004). There were sampling, nonresponse, and poststratification weights. The sampling weight was the product of the inverse of the probability of selection calculated at city, district, and community levels. Nonresponse weights included household and individual aspects. Poststratification weights were calculated using the combination of sex (male, female) and age (<25 years, 25–34, 35–44, 45–54, 55 and older), based on estimated distributions of these characteristics from a national survey (National Bureau of Statistics 2012). The final overall weights were computed as the product of the prior 3 sets of weights. Chi-square analyses were weighted using the overall weights, and the multilevel analysis was weighted using the sampling weights at city and individual levels, with nonresponse and poststratification weights, respectively (Grilli and Pratesi 2004). Because there is no weight statement available for the NLMIXED procedure, these analyses were weighted by means of a macro procedure (Grilli and Pratesi 2004).

Results

A total of 18,310 individuals were identified as potential subjects for this study, of whom 17,424 (95.2%) attended an interview and consented to complete the survey. Of the 17,424 questionnaires received, 16,866 (98.5%) were valid and analyzed (males 52.1%). (See Table 1). Questionnaires were considered invalid due to lack of a response to a key question or to 3 or more general questions and were excluded from the analysis. The demographic characteristics of the omitted subjects resembled those of the included subjects. CHQ was a key variable in this

Table 1. Demographic characteristics of the sample.

Characteristic	*n*	Weighted %
Age (years)		
15–24	3010	17.8
25–34	4394	26.1
35–44	3883	22.0
45–54	2755	16.3
55–78	2824	16.7
Gender		
Male	8655	52.1
Female	8211	47.9
Ethnicity		
Han	15203	90.1
Minority	1663	9.9
Education		
Less than elementary school	1899	11.3
Junior high school	5213	30.9
High school	4914	29.1
Junior college or higher	4840	28.7
Occupation		
Managers/clerks	1553	9.2
Professional	1291	7.7
Commerce/service	2914	17.3
Operations	3890	23.1
Student	1541	9.1
Retired	2286	13.6
Other	3391	20.0

Table 2. Frequency and prevalence of road traffic injury by type.

Type of injury	Unweighted *N*	Weighted prevalence (%) (95% CI)[a]
Automobile[b]	1,704	8.7 (5.9–11.5)
Bicycle	1,532	7.9 (5.3–10.4)
Motorcycle	1,601	8.5 (5.4–11.6)
Pedestrian	1,558	7.7 (5.4–10.0)
Road traffic injury	2,664	13.2 (10.2–16.1)

[a] Denominator for statistics: Total respondents (16,866).
[b] Automobile included car, truck, and bus.

study. the Cronbach's alpha coefficient is 0.73, indicating acceptable reliability. Respondents ranged in age from 16 to 85 years; 17.8% were less than 16 years of age and 16.7% were 50 years or older. Demographic characteristics of this sample aligned with national characteristics (National Bureau of Statistics 2012). We estimated that overall RTI prevalence in the past year among urban residents was 13.2% (95% CI, 10.2–16.1). Table 2 shows the prevalence and distribution of the different types of RTI. Estimated prevalence by type was 8.7, 7.9, 8.5, and 7.7% for automobile (car, truck, or bus), bicycle, motorized scooter or motorcycle, and pedestrian, respectively. RTI prevalence varied widely across study cities. The highest prevalence of RTI was in the western cities of China (Figure 1), notably Xi'an (42.9%) and Xining (36.2%). Only a few eastern cities, such as Shanghai (17.6%), had high prevalence.

Table 3 shows past-year prevalence of RTI across individual and regional characteristics. At the individual level, prevalence was higher among females than males ($P < .001$), minorities than the majority Han ($P < .001$), the more educated ($P < .001$), those with higher annual average household incomes ($P < .001$), and those with a mental disorder ($P < .001$). There also was significant occupational variation ($P < .001$). Age was not significant and related results were not reported in Table 3 for economy. At the regional level, geographic location of residence ($P = .016$ and $P < .001$ for the 4 types of injuries) and mental health disorders ($P = 0.032$ and $P < .001$ for the 4 types of injuries) were significantly associated with RTI.

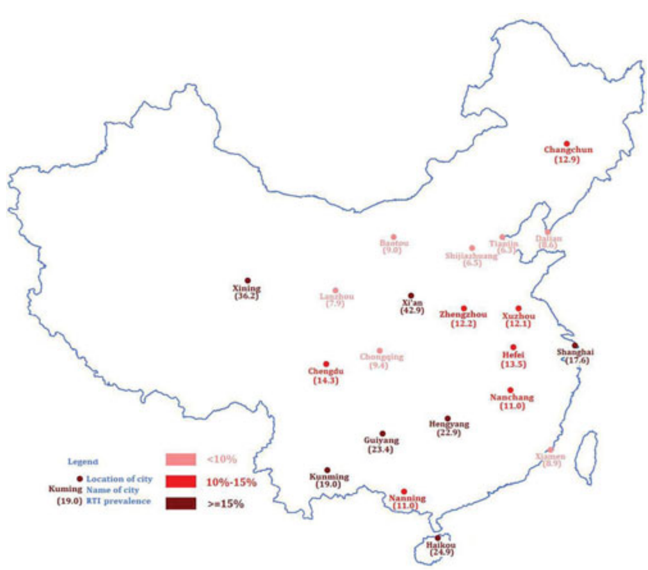

Figure 1. Estimated RTI prevalence in 21 selected Chinese cities (weighted).

Table 4 shows the results of the multilevel, multivariable analyses. At the individual level, the odds of RTI in the past year were higher for the minority group; (OR > 2.00, $P < .01$, for 4 types of injuries), those with a mental health disorder (OR > 2.04, $P < .01$, for the 4 types of injuries), and those with an annual average household income exceeding 50,000 yuan (OR > 1.16, $P < .01$, for the 4 types of injuries). There were also some significant occupational differences (OR > 1.15, $P < .01$, for the 4 types of injuries). Regionally, the odds of RTI in the past year were higher in the northwest than the referent, northeast (OR > 1.15, $P < .01$), and higher for all RTI types except automobile. They were lower in the north across all 4 types. Also irrespective of RTI type, the odds of past-year RTI were higher among the subpopulation with a prevalence of mental health disorders of 20% or higher relative to the referent, the subpopulation whose prevalence was less than 15%.

Discussion

Injury is a serious global public health problem with substantial social and economic costs. This study was the first in China to identify individual- and regional-level correlates of the prevalence of RTI. Results will provide needed evidence to policy makers for understanding and facilitating prevention of RTIs and for informing the design and implementation of prevention programs.

We sought to characterize RTIs among Chinese urban residents, employing data from a large-scale population survey. Thirteen percent of respondents reported such injury during the year prior to survey, representing approximately 170 million people. RTIs are a grave public health problem. Radically transforming lifestyles, China has experienced rapid and profound socioeconomic development, which has led to a great proliferation of vehicles on the road and a burgeoning in vehicle miles traveled. In turn, these changes may have elevated injury rates. The annual average injury mortality rate in China from 1990 to 1997 was 66 per 100,000, accounting for 11% of total deaths (Zhao and Svanström 2003). There was an 81% increase in motor vehicle traffic crash mortality from 1987 to 2001 (Peden 2005). Although the highest growth rate in the number of automobiles is expected in low-income countries, predominant transport modes remain walking, cycling, motorcycling, and public transportation. Most of the increase in motor vehicles is likely to be among 2- and 3-wheelers (Mohan and Tiwari 1998), an issue not addressed in this study. Roads in China often involve diverse groups of users, from vehicles transporting heavy goods to bicyclists and pedestrians. Lack of median strips is highly conducive to motor vehicle crashes and injury. Indeed, China is being confronted by multiple road and traffic safety challenges, including the presence of innumerable poor and excessively vulnerable road users (pedestrians, cyclists, and motorcyclists). Earlier studies reported that pedestrians accounted for between 41 and 75% of total motor vehicle crash fatalities in China (Odero et al. 1997). We estimated that the proportion of pedestrian injuries exceeded half the total among urban residents. The most vulnerable groups among pedestrians are the extremes of the age spectrum, namely, children and the elderly (Koziol-McLain et al. 2000). However, our research found little variation in RTI by age, indicating that

Table 3. Road traffic injury prevalence (weighted) and associated individual and regional variables.

Individual Variable	Unweighted N	Weighted Sample	Prevalence automobile (%)	Prevalence bicycle (%)	Prevalence motorcycle (%)	Prevalence pedestrian (%)
Gender			$P = .018$	$P = .035$	$P = .026$	$P = .052$
Male	8,655	52.1%	5.2%	4.8%	5.4%	5.2%
Female	8,211	47.9	11.8	10.6	11.3	9.6
Ethnicity			$P < .001$	$P < .001$	$P < .001$	$P < .001$
Han	15,203	90.1	6.3%	5.7	5.9	5.5
Minority	1,663	9.9	35.7	33.3	37.4	33.1
Education			$P < .001$	$P < .001$	$P < .001$	$P < .001$
≤Elementary school	1,899	11.3	4.4%	3.0	3.3	3.4
High school	4,914	29.1	3.1	2.6	2.7	2.9
Occupation			$P = .001$	$P < .001$	$P < .001$	$P < .001$
Managers/clerks	1,553	9.2	5.2%	2.6	2.8	3.3
Professionals	1,291	7.7	4.9	5.0	4.1	4.7
Commerce/service	2,914	17.3	3.7	3.6	3.5	3.9
Operations	3,890	23.1	5.3	5.0	5.3	4.9
Students	1,541	9.1	1.1	1.4	1.3	1.4
Retired	2,286	13.6	22.0	20.8	21.5	20.2
Other	3,391	20.0	21.0	18.7	21.2	17.9
Household income (yuan)			$P < .001$	$P < .001$	$P < .001$	$P < .001$
<10,000	3,818	21.6	4.6%	5.9	5.1	5.8
10,000–19,999	5,090	27.2	4.0	4.0	3.8	4.4
20,000–29,999	3,677	21.2	3.6	3.5	3.6	3.6
30,000–39,999	1,754	12.2	7.1	4.4	4.5	3.2
40,000–49,999	1,157	8.2	11.9	9.2	12.1	9.1
Mental disorder			$P < .001$	$P < .001$	$P < .001$	$P < .001$
No	14,056	83.2	2.6%	2.6	2.4	2.7
Yes	2,810	6.6	39.0	65.7	38.6	32.8
Regional Location			$P = .002$	$P < .001$	$P < .001$	$P < .001$
Northeast	1,645	10.0	8.6%	6.5	6.2	6.5
North	1,657	17.8	4.2	4.3	3.2	3.4
Northwest	3,231	7.9	19.1	19.8	20.9	21.6
Southeast	3,889	25.3	12.4	10.8	13.1	9.9
South	3,094	16.4	6.8	6.5	7.9	6.1
Southwest	3,550	22.9	6.2	5.7	5.9	6.3
Mental disorder (%)			$P = .003$	$P < .001$	$P < .001$	$P < .001$
<15	6,403	33.4	8.2%	7.7	6.8	6.8
15–19	5,671	39.2	8.1	5.8	6.0	6.0
20+	4,792	27.3	15.3	14.7	16.1	16.1

traffic safety is a challenge for all ages. A study limitation, however, was that our sample was confined to people 15 years and older.

This study found that RTI prevalence, by type, among Chinese urban residents was 8.7, 7.9, 8.5, and 7.7% for automobiles, bicycles, motorized scooters or motorcycles, and pedestrians, respectively. Close attention must be paid to the large rise in RTIs associated with the major increases in automobiles and vehicle miles traveled that have accompanied the economic transition. Indeed, improvement in roads and general traffic safety in many regions is lagging behind the increase in automobiles (Traffic Management Bureau of the Public Ministry 2013). Although the prevalence of bicycle, motorized scooter or motorcycle, and pedestrian RTIs does not exceed that of automobile RTIs, road users who are not occupants of automobiles emanate from a larger population base. The latter represent the primary road users in Chinese cities and elsewhere because their modes of transportation require relatively small capital outlays. These groups are predominantly low- and middle-income earners with little education, such as farmers and other manual workers, with rural–urban migrants constituting a mushrooming component. An empirical question, we surmise that they possess less awareness of traffic safety than other urban residents, making them more prone to violating traffic laws and regulations. Modifying their risk factors for RTIs needs to be a leading public health objective.

We isolated several individual and regional influences on RTIs among urban residents. One was occupation. The prevalence of automobile-related RTIs was higher among the "other" group than managers and clerks; other may have included the self-employed and those in family service, groups with potentially excess risk exposure, less awareness of prevention, and fewer coping skills. Further research will be necessary to clarify their constituents. Turning to the 3 types of nonautomobile RTIs, urban residents in professions, operations, or who had retired manifested a higher prevalence than did managers and clerks and perhaps also differential risk exposure, prevention awareness, and coping capacity.

Prevalence of RTI was higher in the northwest of China region than in the northeast. This finding may implicate variable socioeconomic status, because the northwest is less developed. Such regional variation in RTIs is consistent with research on global road fatalities, where motor vehicle injury death rates are much higher in low-income and middle-income countries than in high-income countries (Hu et al. 2008; WHO 2009). However, we found no association between regional gross domestic product and RTIs, which may stem from a complex of competing and compensatory factors, such as road construction, traffic facilities and management, bicyclist/pedestrian friendliness, and personal safety awareness and protective behaviors. For example, there are more mountains in the northwest than in the northeast, and roads are of lower quality, issues warranting more

Table 4. Multilevel analysis of the odds of road traffic injury by weighted type. *$P < .05$; **$P < .01$.

Level/type of injury	OR (95% CI) automobile	OR (95% CI) bicycle	OR (95% CI) motorcycle	OR (95% CI) pedestrian
Individual				
Ethnicity				
Han	1.00	1.00	1.00	1.00
Minority	2.00 (1.04, 3.85)**	2.70 (1.32, 5.56)**	3.45 (1.67, 7.14)**	3.13 (1.47, 6.25)**
Occupation				
Managers/clerks	1.00	1.00	1.00	1.00
Professionals	1.23 (0.77, 2.00)	2.33 (1.09, 5.00)**	2.38 (0.85, 6.67)	2.32 (1.15, 4.76)**
Commerce/service	0.95 (0.63, 1.43)	1.61 (0.84, 3.03)	1.72 (0.80, 3.70)	1.70 (0.93, 3.13)
Operations	1.33 (0.86, 2.08)	1.85 (1.01, 3.45)*	2.22 (1.54, 3.12)**	2.00 (1.20, 3.23)**
Student	0.51 (0.25, 1.05)	0.69 (0.31, 1.56)	0.76 (0.38, 1.56)	0.68 (0.34, 1.33)
Retired	1.39 (0.91, 2.13)	2.78 (1.49, 5.26)**	2.70 (1.61, 4.76)**	2.86 (1.45, 5.56)**
Other	1.64 (1.06, 2.13)**	2.70 (1.56, 4.76)**	3.70 (1.56, 7.69)**	2.08 (1.16, 3.70)**
Household income (yuan)				
<10,000	1.00	1.00	1.00	1.00
10,000–19,999	0.90 (0.65, 1.25)	0.58 (0.42, 0.79)**	0.73 (0.47, 1.13)	0.74 (0.57, 0.95)*
20,000–29,999	0.88 (0.55, 1.41)	0.72 (0.45, 1.14)	0.67 (0.33, 1.37)	0.75 (0.40, 1.41)
30,000–39,999	1.19 (0.57, 2.5)	0.60 (0.33, 1.11)	0.55 (0.29, 1.05)	0.47 (0.31, 0.75)
40,000–49,999	0.98 (0.42, 2.33)	0.98 (0.40, 2.38)	1.11 (0.43, 2.94)	0.66 (0.27, 1.61)
50,000+	2.70 (1.23, 5.88)**	3.33 (1.75, 6.25)**	3.45 (1.56, 7.69)**	2.08 (1.16, 3.70)**
Mental disorder				
No	1.00	1.00	1.00	1.00
Yes	9.09 (4.74, 16.67)**	8.33 (4.55, 12.50)**	10.00 (5.00, 20.00)**	7.69 (4.35, 14.29)**
Regional				
Location				
Northeast	1.00	1.00	1.00	1.00
North	0.46 (0.25, 0.86)*	0.63 (0.44, 0.93)*	0.48 (0.31, 0.73)**	0.48 (0.38, 0.61)**
Northwest	1.95 (0.86, 4.47)	2.80 (1.14, 6.83)*	3.00 (1.30, 6.93)*	3.12 (1.30, 7.49)*
Southeast	1.40 (0.87, 2.24)	1.58 (0.85, 2.95)	2.08 (0.88, 4.89)	1.39 (0.75, 2.58)
South	0.64 (0.37, 1.10)	0.82 (0.55, 1.24)	1.06 (0.67, 1.68)	0.75 (0.48, 1.17)
Southwest	0.53 (0.19, 1.42)	0.66 (0.33, 1.33)	0.66 (0.30, 1.44)	0.72 (0.43, 1.19)
Mental disorder (%)				
<15	1.00	1.00	1.00	1.00
15–19	1.19 (0.68, 2.08)	1.02 (0.60, 1.72)	0.83 (0.47, 1.47)	0.69 (0.53, 1.45)
20+	2.04 (1.06, 3.84)**	2.36 (1.20, 5.00)**	2.13 (1.04, 4.35)*	2.17 (1.10, 4.35)**
Null model				
Fixed parameters	8.42**	8.38**	7.30**	7.27**
Random parameters	3.88**	3.63**	2.97**	3.03**
Full model				
Fixed parameters	5.33**	5.53**	4.19**	4.30**
Random parameters	2.52*	2.73**	2.68**	2.76**

research. The north includes 2 highly developed municipalities, Beijing and Tianjin, which have instituted traffic safety measures and enhanced personal safety awareness and protection. This ameliorative action may largely account for its lower prevalence of RTIs relative to the northeast (Jacobs et al. 2000).

The prevalence of RTIs was higher among minorities than the majority Han, a potential product of variable safety awareness, knowledge, and skill (Tiwari 2000). This finding underscores the importance of considering ethnicity in understanding the etiology of injury, in order to develop effective interventions for reducing RTIs among urban residents.

Studies have found that individuals from disadvantaged socioeconomic groups, who reside in poorer areas, face the greatest risk of fatal and nonfatal injury in a road traffic crash, even in high-income countries (WHO 2009). Moreover, drivers with low-status occupations and little education have a higher risk of injury, even adjusting for such confounders as driving exposure (Whitlock et al. 2003). Our results suggest that RTI prevalence is higher among operations workers than managers and clerks. Apparently the former are disadvantaged groups, thus revealing a social equity issue. Explanations for these prevalence discrepancies likely lie in variable exposure to risk and in differential safety awareness and protection (LaFlamme 1998) and call for equal protection.

The finding that individual-level income is positively associated with RTI prevalence runs counter to some previous reports (Cubbin and Smith 2002; Nantulya and Reich 2003) but is consonant with others (Kopits and Cropper 2005). There are several possible explanations for the difference. First, most prior studies focused on fatal or severe injuries. Our study addressed RTI prevalence among the general urban population. Secondly, the relationship between income and RTIs may vary with stage of socioeconomic development (Kopits and Cropper 2005). Over the past 30 years, China has been transitioning from a centralized to a market-based economy. Industrialization and modernization are generating more vehicles and high-density traffic and in the process elevating personal risk of injury on the road. Another possible promoter of RTIs is inherent in improved economic means and greater opportunities for beneficiaries to socialize outside their homes or neighborhoods.

Addressing a gap in the literature, we found that mental health disorders were positively associated with RTIs at both individual and regional levels. Many studies found that traffic injury may induce posttraumatic stress disorder and other mental health disorders (Koren et al. 1999; Koziol-McLain et al. 2000). The psychological consequences of motor vehicle trauma are not always directly proportional to its severity. For example, even relatively minor injury can exert profound psychosocial effects. One study found that within the first year after a traffic crash, nearly a fifth of those injured developed an acute stress reaction, and a quarter displayed psychiatric problems (Blanchard and Veazey 2001). Long-term psychiatric problems mainly include mood disorder (approximately 10% of cases), phobic travel anxiety (20%), and posttraumatic stress disorder (11%). Phobic travel disorder was frequent among drivers and passengers (Mayou et al. 1993). Moreover, mental health discomfort may increase injury risk (Wan et al. 2006; Williams and Andersen 1998). Such associations in China should be examined through observational cohort studies and intervention studies.

Many factors influence RTI prevalence, such as vehicle design and construction, road quality and configuration, and type and enforcement of traffic laws. An essential tool for effective motor vehicle crash injury prevention is adoption of comprehensive safety measures that avoid neglect and historical mistakes. Because human error in complex traffic systems cannot be eliminated entirely, safety must involve both environmental modification and health education. Effective science-based information from China and overseas must be translated into policies and practices that protect motor vehicle occupants and vulnerable pedestrians and other road users. The government should increase investment in improvement of roads and transport facilities. Strengthening road traffic laws and regulations and their implementation is a societal imperative for reducing RTIs.

One major limitation of this study was our inability to distinguish car, truck, and bus injuries within the broad automobile injury category. These distinctions need to made in future research because they harbor important implications for differential characterization of populations at risk and hence the design and targeting of interventions. Another limitation was the cross-sectional design, which precluded causal inference and calls for cohort and other longitudinal studies on motor vehicular trauma in China to advance etiologic understanding and to inform the design and evaluation of generic and tailored interventions. Essential for comprehending risk of RTI, a third study limitation was the failure to capture exposure information; for example, how much respondents walked, biked, drove a car, rode in a car, or rode a motorcycle. Fourth, we did not capture individual safety behaviors, such as use of protective devices. A final study limitation was that the regional mental health variable was a proxy, because it was based on the aggregate of the individual measure. Future studies will need to analyze motor vehicle traffic injury morbidity and mortality in both Chinese urban and rural populations, with reference to a wide array of risk and protective factors. These factors include absent or improper use of seat belts, child car seats, helmets, airbags, stop signs, traffic lights, use of computers and smartphones by drivers, deployment of median strips, variable speed limits, enforcement of traffic laws and regulations, and nature of emergency services and follow-up health care and rehabilitation, including mental health and substance abuse treatment.

We found that both individual- and regional-level variables were associated with RTIs among Chinese urban residents, a finding whose implications transcend wholesale imported generic solutions. This descriptive research demonstrates an urgent need for longitudinal studies across China on risk and protective factors, in order to inform injury etiology, surveillance, prevention, treatment, and evaluation.

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Author contributions

T.Y. and I.R. designed the study. S.J., L.Y., S.P., and X.Y. collected the data. T.Y., Q.Y., and X.Y. analyzed the data and drafted the article. X.Y., I.R., and Q.Y. revised the article.

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