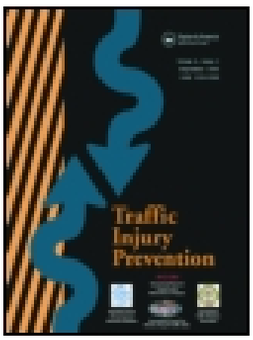

Traffic Injury Prevention

ISSN: 1538-9588 (Print) 1538-957X (Online) Journal homepage: https://www.tandfonline.com/loi/gcpi20

# Behavioral and psychosocial correlates of road traffic injuries: evidence from a nationwide study on Chinese undergraduates

Dan Wu, Tingzhong Yang, Xiaozhao Yousef Yang, Connie H. Hoe, Sihui Peng & Lingwei Yu

**To cite this article:** Dan Wu, Tingzhong Yang, Xiaozhao Yousef Yang, Connie H. Hoe, Sihui Peng & Lingwei Yu (2020): Behavioral and psychosocial correlates of road traffic injuries: evidence from a nationwide study on Chinese undergraduates, Traffic Injury Prevention, DOI: 10.1080/15389588.2020.1770236

**To link to this article:** https://doi.org/10.1080/15389588.2020.1770236

TRAFFIC INJURY PREVENTION
https://doi.org/10.1080/15389588.2020.1770236



# Behavioral and psychosocial correlates of road traffic injuries: evidence from a nationwide study on Chinese undergraduates

Dan Wu[a,b], Tingzhong Yang[c,d], Xiaozhao Yousef Yang[e], Connie H. Hoe[f], Sihui Peng[g], and Lingwei Yu[g]

[a]School of Psychology, Shenzhen University, Shenzhen, Guangdong, China; [b]Department of Psychology/Research Center on Quality of Life and Applied Psychology, Guangdong Medical University, Dongguan, Guangdong, China; [c]Children's Hospital, Zhejiang University School of Medicine, Hangzhou, Zhejiang, China; [d]Injury Control Research Center, West Virginia University, Morgantown, West Virginia; [e]School of Sociology and Anthropology, Sun Yat-sen University, Guangzhou, Guangdong, China; [f]International Health Department, Health Systems Program, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland; [g]Department of Social Medicine/Center for Tobacco Control Research, School of Medicine, Zhejiang University, Hangzhou, Zhejiang, China

**ABSTRACT**

**Objective:** The purpose of this study was to investigate the prevalence and behavioral and psychosocial correlates of road traffic injuries (RTIs) among Chinese university students.

**Methods:** A cross-sectional survey was conducted among fifty universities in China, using a multistage sampling methodology. The participants were asked to report their RTIs in the past year. The chi-square test and binary logistic regression analysis were utilized to identify factors associated with RTIs, including specific types of RTIs.

**Results:** Among the 11,770 participants, a total of 1,482 university students reported at least one RTI yielding an overall weighted injury prevalence of 12.96% over the past year. Estimated weighted prevalence by type was 6.10%, 5.94%, 5.12%, and 5.35% for automobile (car, truck, or bus), bicycle, motorcycle, and pedestrian injuries, respectively. Logistic regression analysis found that students who studied at low-level universities, smoked cigarettes, drank alcohol, slept less than 7 hours, went to bed after 12:00 am, or students with psychological distress were more likely to experience overall and four types of RTIs. Students who studied in the eastern universities had a higher likelihood of automobile injury, motorcycle injury and pedestrian injury than those who studied in western universities.

**Conclusions:** Several critical factors associated with RTIs were identified. These findings have implications for the design and implementation of RTI prevention and interventions programs targeted at university students.

**ARTICLE HISTORY**
Received 21 May 2019
Accepted 11 May 2020

**KEYWORDS**
Road traffic injuries; behavioral factors; perceived stress; psychological distress; Chinese university students

## Introduction

Worldwide, road traffic injuries (RTIs) claim more than 1.35 million lives annually and constitute a major public health and social development issue (World Health Organization 2018). Over 1,000 young people under the age of 25 years are killed in road traffic crashes worldwide every day (Toroyan and Peden 2007). RTIs are the leading cause of death among 15-19-year-olds, and the second leading cause of death among 20-24-years age (Toroyan and Peden 2007). Young adults, such as university students, are among the most vulnerable. The populations in developing countries most at risk for RTIs are pedestrians, cyclists, and passengers (World Health Organization 2018).

Nevertheless, RTI is neither 'bad luck' nor 'accident'; it is predictable and preventable. To address this issue, the risk factors must be identified. Recognizing the key contributors to RTI is a crucial step to enhancing the efficiency of injury prevention initiatives. The conceptual framework of this study was based on the Problem Behavior Theory (PBT) (Jessor 1987), which suggests that social, psychological, and behavioral system can influence problem behaviors. In the extended framework, the adverse consequence of problem behaviors, namely motor vehicle traffic crash in this case, was also included as a concept of problem behavior (Begg and Gulliver 2008).

The most widely investigated risk factors for RTIs are road user behaviors including speed, drink-diving, helmet and seat-belts use, which were engaged in the most direct way to influence traffic crashes (World Health Organization 2018). However, aside from these specific road user behaviors or driving-related behaviors, other general health risk behaviors reflecting individual daily lifestyle such as smoking, drinking, or irregular sleeping patterns have seldom been identified as etiological risk factors for RTIs (Vingilis et al. 2018).

There is a viewpoint supported by several types of research that injuries, including RTIs, are not isolated events

CONTACT Tingzhong Yang tingzhongyang@zju.edu.cn Children's Hospital, Zhejiang University School of Medicine, Hangzhou 310058, China.
Associate Editor Jonathan Rupp oversaw the review of this article.
Supplemental data for this article is available online at https://doi.org/10.1080/15389588.2020.1770236

or one-time occurrences and often referred to as a chronic, recurrent phenomenon (Field and O'Keefe 2004). Some studies have concluded that individual general health risk behaviors are likely a part of a large pattern of behavior leading to injuries and that this pattern of behavior is indicative of a predisposition to take risks (Wu et al. 2019). High health risk behaviors such as smoking, drinking, or irregular sleeping constitute an important aspect of the risk-taking subculture and this subculture exhibits strong norms of encouraging overt displays of problem behaviors and attitudes in comparison to mainstream behaviors and attitudes (Jessor 1987; Wu et al. 2019). Routine activity theory also posits that individuals who spend more time in "unstructured" activities instead of supervised, organized activity are at increased risk of victimization (Hoeben and Weerman 2016).

The potential risk factors for injuries also include psychological variables, which encompass factors that influence mental states, such as depression symptoms, stress, and mental disorder (Gellman and Turner 2013). Mental health is a key determinant of injuries (Wan et al. 2006; Rockett et al. 2017). People with a mental disorder are at excess risk for injuries (Wan et al. 2006; Rockett et al. 2017). Studies have found those who were involved in accidents were distinguished from the non-accidental cases by level of stress, and other psychological factors (Wang et al. 2010). Pressure from parents regarding schoolwork were also highlighted as a significant risk factor for RTIs among middle school students in a rural area of Hunan, China (Jaung et al. 2009). Based on Stress Response Theory, high perceived stress may cause the cognitive, emotional, and behavioral response. RTIs among college students may be a behavioral response to their stressful life or taken as a result of difficulty in coping with stress or maladjustment of distress.

Social differences were also found to be a factor in traffic injuries in childhood (Laflamme and Diderichsen 2000). Mortality and morbidity of traffic injury are often higher among children from lower social positions and in more deprived socioeconomic areas (Laflamme and Diderichsen 2000). Social factors include the relationship a person has with their environment. Social environmental variables are including socioeconomic, work, and living atmosphere, and cultural aspects. According to Jessor (1987), the PBT assumes that, "all behaviour is the results of person-environment interaction". The environment can also promote or hinder whether individuals engage in positive or negative health behavior (Gellman and Turner 2013). University environmental factors whether can potentially contribute to RTIs among undergraduates have also been a neglected research focus.

Although there is substantive literature on behavioral or psychosocial factors associated with injury, few have focused on the association between general health risk behaviors and RTIs, particularly in China. Most RTI studies were based on the epidemiological perspective, and focused on children and adolescent or conducted in foreign culture (Dong et al. 2011; Jaung et al. 2009). RTIs including each specific category of RTI among undergraduates and its associated risk factors have been the subject of very little research (Vingilis et al. 2018). Furthermore, the studies using a population-based sampling method with nationwide representativeness have rarely been conducted. Thus, the purpose of this study was to assess the prevalence of overall and different types of non-fatal RTIs and to identify the related risk factors among Chinese university students, who constitute an important risk group for RTIs. Specifically, this study examines whether the general health risk behaviors (cigarette smoking, alcohol consumption, irregular sleep pattern) and psychological problems (severe stress/psychological distress) in combination with university environmental factors (location/type) increase the likelihood of the occurrence of RTIs at a nation-wide scale.

## Methods

### Sample

The present study was conducted as a part of Global Health Professions Student Survey (GHPSS) in China in 2013 (Yang et al. 2015). In comparison with the original GHPSS, the extended Chinese version also included additional health behavioral and psychological items besides smoking issues. For instance, it contained the assessment of injury, sleeping, drinking, as well as perceived stress and mental health. The survey utilized multi-stage sampling procedure. In stage 1, fifty universities were selected based on regional diversity, existing research collaboration with the principal investigator, and the site investigators' willingness to participate. In stage 2, the sampling strategy involved the selection of levels within each university. All levels that had medical professional courses were selected in each university. In stage 3, one-third of those classes were randomly selected from each level. In stage 4, all students enrolled in those classes were recruited as study participants. Sampling weights corrected for differential probabilities of selection. The survey was approved by the Ethics Committee of the Medical Center at Zhejiang University. The survey was conducted in class, where the principal investigators of each university explained the study to the students and obtained their informed consent before administering the survey in the classrooms. The questionnaires were collected instantly by trained researchers after the participants completed them in class. The actual questionnaire used in the current study was in Mandarin and required approximately 10 minutes to complete.

### Measures

Details of the measures used in this study are briefly described below.

### Dependent variables

#### Road traffic injury status

The questionnaire asked students to identify road traffic injuries, which required medical attention during the past

12 months. A reportable injury in this study was defined as any injury satisfying at least one of the following criteria: the injury required (1) a doctor's treatment, (2) an emergency room visit or other emergency care, (3) the victim to rest for a minimum of one-half day (Rockett et al. 2017).

Road traffic injuries were defined as any injury that involved in traffic accidents (Rockett et al. 2017). The participants were asked to report if (1) they were the driver or passenger in an automobile (car, truck, or bus) crash, (2) they had been involved in a cycling crash, (3) they had been riding a motorized scooter or motorcycle at the time of their crash or (4) they had been involved in a crash as a pedestrian. The answer options for each of the above questions were: "No; Yes, once; Yes, twice; Yes, three times or more". For the final statistical analysis in this study, this key outcome variable was recoded as a binary dependent variable (1 = injury and 0 = no injury) (Rockett et al. 2017).

## Independent variables

### Sociodemographic characteristics

This section of the questionnaire asked students to provide sociodemographic information including their age, gender, ethnicity, academic major, and parental occupation.

### University factors

*University location* was divided into eastern, middle, and western region of China based on geographic distribution.

*University type* was determined using the Chinese university ranking system put forth by the National Ministry of Education (Yang et al. 2015). According to the National Higher Education Entrance Examination Inquiry System, high-level universities refer to the first-tier universities, middle-level universities stand for the second-tier universities, and low-level universities were those Tier 3 institutions.

### Behavioral factors

*Smoking status*: To assess smoking status, participants were asked whether they currently smoked. The response options were "Yes, smoke every day; Yes, smoke on one or more days but not every day; No" (Yang et al. 2015). We coded these measures dichotomously as 1= smoking and 0 = no smoking.

*Alcohol drinking status*: To assess drinking status, participants reported whether or not they currently drink alcohol. The response options were "Yes, drink every day; Yes, drink on some days but not every day; No". We coded these measures dichotomously as 1= alcohol drinking and 0 = no drinking.

*Sleeping status*: Students were asked when they usually go to bed and how many hours of sleep they usually get per night on normal weekdays. "Late sleepers" slept later than the median. This means students who went to sleep after 12:00 am were categorized as a "late sleeper" in this study (Asarnow et al. 2014). For the duration of sleep, response categories were less than 6 hours, 6-7 hours, 7-8 hours, 8-9 hours, and 9 hours or longer. Short sleep duration was defined as sleeping less than 7 hours (Watson et al. 2015).

### Psychological factors

***Stress status.*** Stress symptoms were measured by the Perceived Stress Scale, Chinese version (CPSS). Questions included: "How often have you felt nervous or stressed?", "How often have you felt that you were unable to control the important things in your life?", and so on. This scale comprises 14 items for assessing perceptions of stress during the previous month. Items are rated on a 5-point Likert-type scale, and range from 0 (never) to 4 (very often) (Yang et al. 2012). Item scores were summed to yield a total, with higher scores indicating higher perceived levels of stress (Yang et al. 2012). Following previous practice, severe stress was operationalized as a score >=25 (Yang et al. 2012). The Cronbach's Alpha was 0.89 in this study, showing acceptable internal reliability of the CPSS.

***Mental health status.*** The mental health status among participants was measured by the 12-item Chinese Health Questionnaire (CHQ). The CHQ was developed in Taiwan and derived from the General Health Questionnaire (GHQ) (Chong and Wilkinson 1989). Similar to the widely-used GHQ, the CHQ was designed to screen for mental disorders in community settings (Chong and Wilkinson 1989). The CHQ version utilized in the current study was the Mandarin version which was revised and adapted by Yang and colleagues according to Chinese mainland culture (Yang et al. 2003). It also has acceptable reliability and validity and has been widely used to assess mental health status in the community and primary care setting across China (Ma et al. 2007). Items in this questionnaire were rated on a 4-point scale (not at all, same as usual, rather more than usual, or much more than usual). A bimodal scale (0-0-1-1), which is the most common scoring method, was used in this study. The summed score was calculated to measure the severity of the psychological distress. A cutoff score of 3 or more had been used in previous studies using the CHQ to signify as psychological distress (Chong and Wilkinson 1989; Yang et al. 2003).

## Data Analysis

All data were entered into a database using Epi Data 3.0. The dataset was then imported into SPSS 18.0 for statistical analyses. Descriptive statistics were calculated for all variables. Chi-square analyses were conducted to determine differences in road traffic injuries across the selected demographic, behavioral, and psychosocial characteristics. Next, binary logistic regression analysis was conducted to test associations between the independent and dependent variables. The independent variables in this analysis were those variables that emerged as statistically significant in the Chi-square tests. A Wald test was used to test the statistical significance of each coefficient in the model. The odds ratio

Table 1. Frequency and prevalence of university students' road injury by type.

| Type of injury | N | Prevalence (%) (95% C.I.)[a] | |
|---|---|---|---|
| | | Unweighted | Weighted |
| Overall road traffic injury | 1482 | 12.59 (11.99-13.19) | 12.96 (12.77-13.15) |
| Automobile[b] | 623 | 5.29 (4.89-5.70) | 6.10 (5.96-6.23) |
| Bicycle | 653 | 5.55 (5.13-5.96) | 5.94 (5.80-6.07) |
| Motorcycle | 629 | 5.34 (4.94-5.75) | 5.12 (5.00-5.25) |
| Pedestrian | 694 | 5.90 (5.47-6.32) | 5.35 (5.22-5.48) |

[a]Denominator for statistics: Total respondents (11,770).
[b]Automobile included car, truck, and bus.

(OR) expressed the relative likelihood of having a probable injury.

The SPSS complex samples procedure was applied for analysis and the data were weighted to adjust for varying selection probabilities. Final overall weight was computed as the product of the sampling weight and post-stratification weight. The sampling weight was the inverse of the probability of class selection, calculated at university, and the post-stratification weight was calculated in relation to gender, based on estimated distributions of this characteristic from a national survey (Wu et al. 2019).

## Results

A total of 11,954 individuals agreed to participate this study with the response rate of 97.5%. Of these students, 11,770 (98.5%) were included in this analysis. Of the 11,770 participants, 52.2% were males, and 47.8% were females. The majority of students were Han ethnicity (94.2%) and aged from 20 to 22 years (74.4%). Medical students accounted for 40.4% of all participants and about seventy-one percentage of students' parents worked as a worker, farmer or merchant. Nearly fifty-five percentage of students studied at universities located in the eastern region of China and 57.6% of students studied at middle-level universities.

A total of 1,482 university students reported at least one RTI yielding an overall weighted injury prevalence of 12.96% over the past year. Table 1 shows the prevalence and distribution of different types of RTI. Estimated prevalence by type was 6.10%, 5.94%, 5.12%, and 5.35% for automobile (car, truck, or bus), bicycle, motorcycle, pedestrian injury, respectively.

According to the univariate chi-square analysis, age, gender, parental occupation, university location, and type were found to be related to the prevalence of overall RTI and each type of RTI. Ethnicity was correlated with automobile injury, motorcycle injury, and pedestrian injury. Majoring in a non-medical field was associated with bicycle injury, motorcycle injury, and pedestrian injury. In addition, the overall RTI prevalence and four types of RTI prevalence were all found to be higher among those students who were smoking, drinking alcohol, and sleeping less than 7 hours, and going to bed after 12:00 am. The students with higher perceived stress or psychological distress had a higher overall and each type of RTI prevalence.

Tables 2a-c present the results of the multivariate analysis. The risk of overall RTI was 2.70 (95% CI 2.26-3.23) times more likely among students who studied at the universities of low-level. The four different types of RTIs showed a similar difference with university level. Students who studied in the eastern region of China had a higher odds of automobile injury, motorcycle injury, and pedestrian injury, but had a lower odds of bicycle injury in comparison with those studied in the western region. The odds of overall RTI in the past year were 1.09, 1.63, 1.21, 1.46 times higher among those students who were smoking, drinking alcohol, sleeping less than 7 hours, and going to bed after 12:00 am, respectively. In addition, the odds of overall RTI was 1.71 (95% CI 1.64-1.78) times higher among those who had psychological distress. Similar results were shown in the automobile injury, bicycle injury, motorcycle injury, and pedestrian injury models.

## Discussion

This is one of the few studies in the world to identify the prevalence and individual- and university-level correlates of RTI among college students from a large-scale population survey. Our results showed that approximately one in eight Chinese college students reported at least one RTI in the past year. In this study, male college students reported higher overall, and each type of RTI prevalence than female students. This is consistent with results from other domestic as well as foreign studies, which showed that more males than females suffer RTIs (Jaung et al. 2009; Dong et al. 2011; Raina et al. 2016). Higher risk of RTIs among males might be associated with greater exposure to driving or riding than female (Raina et al. 2016). Another potential explanation is that men might be engaged in a broader range of outdoor activities compared to women (Raina et al. 2016). RTI prevention and intervention programs should target male students.

Our results are consistent with the extended PBT in that it shows how environmental, behavioral, and psychological factors all influence RTIs which was taken as an extended problem behavior. The findings of this study suggest that changes in Chinese university environment may also have contributed to increased RTIs. The social-psychological framework of problem-behaviors theory emphasized the vital influence of perceived environment system for adolescent behaviors (Jessor 1987; Begg and Gulliver 2008). High-level universities might have more human and financial resources to build better road traffic infrastructure. Furthermore, students who were studying at high-level universities might have stronger safety awareness and healthier lifestyle and behaviors. The different geographic location of universities might reflect different economic and traffic development status. Rapid economic development would bring a burgeoning proliferation of the possession of private vehicles. Several studies showed that there is a close association between vehicle growth and road traffic crashes and injuries (Toroyan and Peden 2007). Students who studied in the east of China might have more exposure opportunities to use or have contacted such transportation systems to suffer increased risks of automobile, motorcycle, or pedestrian

**Table 2a.** Analysis of binary logistic regressions for environmental correlates of college students' road traffic injury by type.

| | Odds Ratio (95% C.I.) | | | | |
|---|---|---|---|---|---|
| Group | Overall | Automobile | Bicycle | Motorcycle | Pedestrian |
| University location | | | | | |
| East | 0.99(0.95-1.04) | 1.34(1.25-1.43)** | 0.76(0.71-0.81)** | 1.60(1.48-1.73)** | 1.60(1.48-1.72)** |
| Middle | 0.93(0.88-0.99)* | 1.08(0.99-1.18) | 1.03(0.94-1.12) | 1.56(1.42-1.71)** | 1.48(1.35-1.62)** |
| West | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Type of University | | | | | |
| High level | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Middle level | 1.51(1.45-1.56)** | 1.60(1.51-1.69)** | 1.12(1.05-1.19)** | 2.13(2.01-2.27)** | 1.79(1.69-1.90)** |
| Low level | 2.70(2.26-3.23)** | 2.78 (2.13-3.63)** | 1.60(1.20-2.14)** | 3.09(2.34-4.07)** | 2.60(2.06-3.29)** |

*$p < 0.05$.
**$p < 0.01$.
Demographic characteristics, behavioral, and psychological factors were controlled.

**Table 2b.** Analysis of binary logistic regressions for behavioral correlates of college students' road traffic injury by type.

| | Odds Ratio (95% C.I.) | | | | |
|---|---|---|---|---|---|
| Group | Overall | Automobile | Bicycle | Motorcycle | Pedestrian |
| Sleep duration per night | | | | | |
| Less than 7 hours | 1.21 (1.16-1.26)** | 1.58(1.49-1.67)** | 1.25(1.18-1.32)** | 1.17 (1.10-1.25)** | 1.41(1.33-1.50)** |
| 7 hours and more | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Bedtime | | | | | |
| 12:00 am or later | 1.46(1.39-1.53)** | 1.43(1.34-1.53)** | 1.22(1.14-1.30)** | 1.71(1.58-1.84)** | 1.64(1.53-1.77)** |
| Before 12:00 am | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Current smoking | | | | | |
| Yes | 1.09 (1.04-1.14)** | 1.87(1.76-1.98)** | 1.10(1.04-1.18)** | 1.60(1.50-1.71)** | 2.13(1.99-2.29)** |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Current alcohol drinking | | | | | |
| Yes | 1.63 (1.57-1.70)** | 1.32(1.25-1.39)** | 1.70(1.61-1.80)** | 1.11(1.05-1.18)** | 1.60(1.51-1.69)** |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

*$p < 0.05$.
**$p < 0.01$.
Demographic characteristics, environmental, and psychological factors were controlled.

**Table 2c.** Analysis of binary logistic regressions for psychological correlates of college students' road traffic injury by type.

| | Odds Ratio (95% C.I.) | | | | |
|---|---|---|---|---|---|
| Group | Overall | Automobile | Bicycle | Motorcycle | Pedestrian |
| Perceived stress | | | | | |
| High | | | 1.28(1.21-1.35)** | 1.21(1.14-1.28)** | |
| Low | | | 1.00 | 1.00 | |
| Psychological distress | | | | | |
| Yes | 1.71(1.64-1.78)** | 2.11(2.00-2.23)** | 2.88(2.73-3.04)** | 2.35(2.22-2.49)** | 2.79(2.64-2.95)** |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

*$p < 0.05$.
**$p < 0.01$.
Demographic characteristics, environmental, and behavioral factors were controlled.

injuries. On the contrary, the western region is less developed with fewer vehicles compared with the eastern region. Students who studied in western universities might have more opportunities to use a bicycle as a travel tool which would lead to an increase of corresponding injuries. The implications for these results were that prevention education and enforcement for traffic safety should be prominent on university campuses. The recognition of the profound contribution of road safety to the health of Chinese undergraduates should be acknowledged by the government and related stakeholders.

The results of the current study were congruent with previous studies that examined the relationship between health risk behaviors and RTIs (Wu et al. 2019; Begg and Gulliver 2008; Merrill 2019). Road traffic injury prevention should not be only limited the traffic-related behaviors and must be incorporated into a broad range of health behavioral activities addressing general lifestyle. Early identification of irregular sleep patterns, smoking, or alcohol drinking, could provide opportunities for early treatment and preventive counseling and thus prevent potential RTIs and their negative consequences.

Short sleep duration and late bedtime would induce sleepiness, fatigue, and lack of concentration which may affect the performance of daily activities (Pandi-Perumal et al. 2006; Lam and Yang 2007). One study found that 17% of the traffic crashes in the UK resulting in death or injury was sleep-related (Flatley et al. 2004). There is a considerable body of evidence illustrating that sleepiness contributes to various accidents in the transport system (Pandi-Perumal et al. 2006). Hence, a shorter duration of sleep or late bedtime can potentially be considered as a primary risk factor for RTIs.

The findings also show that current cigarette smoking and alcohol use increased the odds of occurrence of RTIs among Chinese college students. Direct toxicity, including physiological impairment and withdrawal symptoms caused by smoking and alcohol, is one possible explanation for this finding (Vingilis et al. 2018; Wu et al. 2019). Lighting and removing a cigarette as well as blurred vision from cigarette smoke can distract drivers or pedestrians; this could be another possible explanation for this finding (Vingilis et al. 2018). Moreover, Jessor's problem-behaviors theory also pointed out that problem behaviors of adolescence, such as drinking alcohol and smoking, reflect lifestyle factors that are directly related to the likelihood of crash involvement (Jessor 1987). We may think of smoking and drinking, as health risk behaviors. As young people are prone to display these health risk behaviors on their social platforms, it may in turn affect the peer by normalizing risky behaviors, including traffic-related risk behaviors. From this perspective, these health risk behaviors may be associated with RTIs. Our results confirmed that RTIs are an adverse consequence of problem behaviors, including alcohol use (Field and O'Keefe 2004).

Students with high perceived stress reported a higher percentage of automobile injury and motorcycle injuries. According to the stress response model, the high perceived stress may lead to behavioral responses including road user's risky behaviors that then induce RTIs. We also found a strong association between psychological distress and RTIs. Once psychological distress was taken into account, perceived stress had limited utility for predicting RTI status. This particular finding is in consistent with a previous study that observed a positive correlation between psychological distress and RTIs at both individual level and regional level among Chinese urban citizens (Rockett et al. 2017). The possible explanation for RTIs among college students with psychological distress might be based on their disrupted emotional statuses and judgment capability, as well as changes in perception of potential dangers (Wan et al. 2006). Mental health problems may also occur as a result of induced strains arising from life stress, health risk behaviors, and road injury. That is, road injury may affect mental health problems. However, whether the greater occurrence of RTIs among students with psychological distress is a phenomenon attributable to the psychological status itself, or merely a reflection of a wider pattern of RTIs affecting mental health, is unclear and deserves greater scrutiny in future research. To date, our study is among the first to characterize RTIs among college students with psychological distress. The recognition of psychological distress as a risk factor for RTI calls for a reexamination of the resource allocation for RTI intervention and highlights the college students with high perceived stress and psychological distress as a prime target population for RTI prevention efforts.

Some limitations should be considered when interpreting the results of this study. First, we used a cross-sectional survey, which limits our ability to infer the causality in the relationship between these risk factors and RTIs. Second, the possibility of recall bias might exist. RTIs, in the past 12 months were self-reported by university students in this study and were unable to be verified by medical records. Furthermore, there might also be a selection bias against students who were seriously injured and did not return to class when the survey was conducted, or against students who were involved in a fatal road traffic crash. Third, this study did not differentiate between the passengers and drivers who sustained an automobile injury; this requires further investigation in the future research. Moreover, we did not differentiate between students who experienced multiple types of RTIs and students with high frequency of one specific type of RTIs in this study. Future studies should explore this important phenomenon.

In conclusion, this study recommends improving RTI surveillance systems and focusing on RTI prevention programs among college students, especially for male students and students who study at low-level universities in China. Beyond conventional strategies for RTI prevention that is related to specific road user behaviors, studies should test the benefits of improved overall health behaviors and mental health programs on RTIs.

## Acknowledgments

We would like to thank our local teams from the "Building advocacy capacity for tobacco control in medical universities in China (Bloomberg global tobacco control project)" project for organizing the data collection.

## Conflicts of interest

The authors declare that they have no conflict of interest.

## Funding

This study was partly funded by the National Natural Science Foundation of China (Grant No. 71490733), and Natural Science Foundation of Guangdong Province of China (Grant No. 2018A030307002).

## ORCID

Dan Wu http://orcid.org/0000-0003-0849-0297
Tingzhong Yang http://orcid.org/0000-0001-8234-0938
Xiaozhao Yousef Yang http://orcid.org/0000-0001-7354-7208
Connie H. Hoe http://orcid.org/0000-0001-8008-4010

## References

Asarnow LD, McGlinchey E, Harvey AG. 2014. The effects of bedtime and sleep duration on academic and emotional outcomes in a nationally representative sample of adolescents. J Adolesc Health. 54(3):350–356. doi:10.1016/j.jadohealth.2013.09.004

Begg DJ, Gulliver P. 2008. A longitudinal examination of the relationship between adolescent problem behaviors and traffic crash involvement during young adulthood. Traffic Inj Prev. 9(6):508–514. doi:10.1080/15389580802335117

Chong MY, Wilkinson G. 1989. Validation of 30- and 12-item versions of the Chinese Health Questionnaire (CHQ) in patients admitted for general health screening. Psychol Med. 19(2):495–505. doi:10.1017/s0033291700012526

Dong X, Peek-Asa C, Yang J, Wang S, Chen X, Chi G, Ramirez M. 2011. The association of road safety knowledge and risk behaviour with paediatric road traffic injury in Guangzhou, China. Inj Prev. 17(1):15–20. doi:10.1136/ip.2010.027540

Field CA, O'Keefe G. 2004. Behavioral and psychological risk factors for traumatic injury. J Emerg Med. 26(1):27–35. doi:10.1016/j.jemermed.2003.04.004

Flatley D, Reyner LA, Horne JA. Sleep-related crashes on sections of different road types in the UK (1995-2001). Road Safety Research Report 52; 2004.

Gellman MD, Turner JR. (eds). 2013. Encyclopedia of behavioral medicine. New York (NY): Springer; doi:10.1007/978-1-4419-1005-9.

Hoeben EM, Weerman F. 2016. Why is involvement in unstructured socializing related to adolescent delinquency?. Criminology. 54(2): 242–281. doi:10.1111/1745-9125.12105

Jaung MS, Yu S, Stallones L, Xiang H. 2009. Road traffic injuries among middle school students in a rural area of China. Traffic Inj Prev. 10(3):243–251. doi:10.1080/15389580902775147

Jessor R 1987. *Risky driving and adolescent problem behaviour: theoretical and empirical linkage*. In: Benjamin, T, editors. Young Drivers Impaired by Alcohol and Drugs. New York: Royal Society of Medicine Services. p. 97–110.

Laflamme L, Diderichsen F. 2000. Social differences in traffic injury risks in childhood and youth-a literature review and a research agenda. Inj Prev. 6(4):293–298. doi:10.1136/ip.6.4.293

Lam LT, Yang L. 2007. Short duration of sleep and unintentional injuries among adolescents in China. Am J Epidemiol. 166(9): 1053–1058. doi:10.1093/aje/kwm175

Ma H, Zhang N, Sun Y. 2007. Mental health status and personality characteristic among Nanjing residents. Chin J Health Psychol. 15(6):536–537.

Merrill RM. 2019. Injury-Related Deaths according to Environmental, Demographic, and Lifestyle Factors. J Environ Public Health. 2019: 6942787. doi:10.1155/2019/6942787

Pandi-Perumal SR, Verster JC, Kayumov L, Lowe AD, Santana MG, Pires MLN, Tufik S, Mello MT. 2006. Sleep disorders, sleepiness and traffic safety: a public health menace. Braz J Med Biol Res. 39(7): 863–871. doi:10.1590/s0100-879x2006000700003

Raina P, , Sohel N, Oremus M, Shannon H, Mony P, Kumar R, Li W, Wang Y, Wang X, Yusoff K, Yusuf R. 2016. Assessing global risk factors for non-fatal injuries from road traffic accidents and falls in adults aged 35-70 years in 17 countries: a cross-sectional analysis of the Prospective Urban Rural Epidemiological (PURE) study . Inj Prev. 22(2):92–98. doi:10.1136/injuryprev-2014-041476

Rockett IR, Jiang S, Yang Q, Yang T, Yang XY, Peng S, Yu L. 2017. Prevalence and regional correlates of road traffic injury among Chinese urban residents: a 21-city population-based study. Traffic Inj Prev. 18(6):623–630. doi:10.1080/15389588.2017.1291937

Toroyan T, Peden M (eds). 2007. Youth and road safety. Geneva: World Health Organization.

Vingilis E, Pederson LL, Seeley J, Ialomiteanu AR, Wickens CM, Ferrence R, Mann RE. 2018. Is there a link between motor vehicle collisions and being a cigarette smoker in Canada? Analysis of survey data from Ontario from 2002 to 2014. Traffic Inj Prev. 19(4): 364–370. doi:10.1080/15389588.2017.1419342

Wan JJ, Morabito DJ, Khaw L, Knudson MM, Dicker RA. 2006. Mental illness as an independent risk factor for unintentional injury and injury recidivism. J Trauma. 61(6):1299–1304. doi:10.1097/01.ta.0000240460.35245.1a

Wang P, Rau PLP, Salvendy G. 2010. Road safety research in China: review and appraisal. Traffic Inj Prev. 11(4):425–432. doi:10.1080/15389581003754593

Watson NF, Badr MS, Belenky G, Bliwise DL, Buxton OM, Buysse D, Dinges DF, Gangwisch J, Grandner MA, Kushida C, et al. 2015. Recommended amount of sleep for a healthy adult: a joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. Sleep. 38(6):843–844. doi:10.5665/sleep.4716

World Health Organization 2018. Global status report on road safety 2018. Geneva. Switzerland: WHO Press.

Wu D, Yang T, Cottrell RR, Zhou H, Feng X. 2019. Prevalence and behavioural associations of unintentional injuries among Chinese college students: a 50-University population-based study. Inj. Prev. 25(1):52–59. doi:10.1136/injuryprev-2018-042751

Yang T, Huang L, Wu Z. 2003. The application of Chinese Health Questionnaire (CHQ) for mental disorder screening in community settings in mainland China. Chin Epidemiol. 24(9):769–773.

Yang T, Rockett IRH, Lv Q, Cottrell RR. 2012. Stress Status and Related Characteristics among Urban Residents: A Six-Province Capital Cities Study in China. PLoS One. 7(1):e30521. doi:10.1371/journal.pone.0030521

Yang T, Yu L, Bottorff JL, Wu D, Jiang S, Peng S, Young KJ. 2015. Global Health Professions Student Survey (GHPSS) in tobacco control in China. Am J Health Behav. 39(5):732–741. doi:10.5993/AJHB.39.5.14