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The association of road safety knowledge and risk behaviour with paediatric road traffic injury in Guangzhou, China

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Abstract

Background—This study describes road traffic injuries among school-aged children in Guangzhou, China, and examines the effect of road safety knowledge and risk behaviours on road traffic injuries.

Methods—A stratified cluster sample of 3747 children from six primary schools and six middle schools in Guangzhou, China, was surveyed. Data were collected on sociodemographic factors and road traffic injuries during the past year. Knowledge about road safety rules was assessed using a 14-item road safety knowledge index, and risky road safety behaviours were measured using a 25-item road safety behaviour index.

Results—A total of 403 (10.8%) students reported having at least one road traffic injury during the past 12 months. A high proportion of injuries was found among children who were boys, in primary school and from the suburbs. Bicycle-related injuries were the most common (46.0% of all injuries). Motor vehicle-related injuries had higher hospitalisation rates and worse

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Competing interests None.

Ethics approval This study was conducted with the approval of the Medical College of Jinan University.

Contributors XD supervised the conduct of the study, data analysis and interpretation; CPA supervised data analysis and development of the manuscript; JY supervised and conducted data analysis and contributed to development of the manuscript; SW was the senior investigator for the study and contributed to study design and protocol and editing of the manuscript; XC and GC facilitated conducting the study and data collection and interpretation; MR contributed to data analysis and interpretation.

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psychological impact than bicycle or pedestrian injuries. Children with low and medium road safety knowledge had 1.5 to 3 times the odds of injury compared with students with high road safety knowledge. Students with high scores on the risky road behaviour index had twice the odds of injury (OR 2.04, 95% CI 11.47 to 2.84) compared with students with low scores.

Conclusion—Better road safety knowledge and the avoidance of walking or cycling-related risk behaviours are protective factors for road traffic injuries among Chinese school children. More injury prevention programmes are needed to improve road safety knowledge and reduce risk behaviours.

Road traffic injury is a public health problem throughout the world, particularly in China, which has a large population and increasing motor vehicle ownership during the past decade.[1] With the quickly growing economy, motor vehicle production in China has tripled since the early 1990s.[2] The proportion of all deaths caused by traffic and transportation injuries increased from 15% in 1987–8 to 34% in 2005–6, and the corresponding death rates (standardised to the 2000 population) increased 81% from 12 to 22 per 100000.[3] In 2005 alone, 98 738 individuals were killed and 469911 were injured in road traffic crashes, resulting in 1.88 billion Chinese yuan in direct economic losses.[4] Road traffic injuries are the leading cause of death for all ages under 45 years in China.[5,6]

The Ministry of Education of China issued a report in 2006 that identified road traffic crashes as the leading cause of injury among school-aged children, accounting for 45.7% of all injuries.[7] Data from the Transportation Bureau of the Ministry of Public Security showed that 4205 school children were killed and more than 21000 were injured in road traffic crashes in 2004.[8]

In order to develop effective prevention strategies to curb the rapid growth of traffic injuries, the risk factors must first be understood. However, most published studies that identified various sociodemographic, behavioural and environmental factors for road traffic injuries have focused on populations in developed countries, while the body of evidence for developing countries, such as China, is lacking. The risk factors and associated prevention measures examined in developed countries may not be directly transferable to China given the differences in social and cultural contexts. For example, exposure to the road environment differs, as most students in China get to school by bicycling, walking, or taking public transportation (bus or subway), with only a very small proportion of students driven by parents. Furthermore, differences in cultural behavioural characteristics related to traffic safety may indicate distinct associations between personal and environmental characteristics with road traffic injury risk.

Research on road traffic crashes in China is growing, and several studies have measured children's knowledge of the traffic environment.[9–11] Knowledge about safe and risky situations may influence behaviours when negotiating traffic hazards and thus impact the risk of injury. Relationships between safety knowledge, behaviour and injuries have not been examined among Chinese children although they spend a substantial amount of time interacting with the road environment. The purpose of this study is to first describe the frequency of self-reported road traffic injuries in a large sample of school children in

Guangzhou City, China, and then to identify how road safety knowledge and risky behaviours are associated with road traffic injuries.

MATERIALS AND METHODS

We conducted a cross-sectional survey of children in grades 4 to 9 who attended six primary and six secondary schools in Guangzhou City, China. The survey was conducted in April 2009. Guangzhou City is the capital and largest city in South Chinas Guangdong province, with a population of nearly 9.94 million.[12]

Selection of study participants

A two-stage stratified cluster sampling design was used to recruit a representative sample of participants. The sample pool included all 10 school districts in Guangzhou City, which has 1076 primary schools and 465 secondary schools (889 000 primary school students and 401 632 secondary school students, respectively). We first randomly selected one suburban (Baiyun district) and two urban districts (Tianhe and Yuexiu districts), using stratified probability proportional to size cluster sampling. We then randomly selected two primary schools and two secondary schools from each of the three selected districts, using computer-generated random numbers. All students in grades 4, 5 and 6 in the six selected primary schools and all children in grades 7, 8 and 9 in the six selected secondary schools were invited to participate in the study. Principals in the selected schools were contacted, and all agreed to participate in the study.

Data collection procedures

After a brief introduction by the principal investigator, children were invited to participate in a voluntary, anonymous, paper—pencil survey in their classrooms. The principal investigator and/or research staff provided survey instructions and answered questions that students had regarding the survey or study. The completed surveys were collected at the study sites on the same day the survey was conducted.

Of a total of 4013 eligible students (excluding 13 students who were not present on the day the survey was conducted), 4000 surveys were distributed and 3950 were returned, with a response rate of 98.8%. Of the 3950 returned surveys, 203 (5.1%) surveys were excluded from the analysis because of missing data on road traffic injury experiences. A total of 3747 valid surveys were thus included, with a valid response rate of 93.7% and a participation rate of 93.4%.

Study instrument and variables

The survey was developed based on existing traffic injury literature[9–11,13–16] and data from an observational study of local traffic conducted at road junctions in the vicinity of the schools. The draft of the survey was reviewed by injury experts and teachers from the primary and secondary schools, and pilot tested with 40 primary school students and 40 secondary school students. The final version of the survey included four sections of questions: demographic information of the participants (eg, sex, age, grade, parents' educational background, single or multiple child family, and the main form of transportation

to and from school); road traffic-related risky behaviours; road safety knowledge and self-reported road traffic injuries. A road traffic injury was defined as any injury that occurred while walking, bicycling, or riding in a vehicle that required medical attention or time away from school for 1 day or longer.

The Road Traffic Risk Behaviour Index was developed to measure road traffic risk behaviours in the past 1 month. The index includes 24 items asking about specific risk behaviours related to walking (five items), cycling (10 items), travelling by bus (three items), by subway (three items) or by car (three items). Example questions included: 'Over the past 1 month, how often have you ridden your bicycle using only one hand?', and 'Over the past 1 month, how often have you ridden your bicycle carrying another person?' The students were instructed to respond to each behaviour question, using response choices of: 0, never; 1, occasionally; 2, sometimes; 3, very often and 4, always.

The index score for each particular behavioural category (eg, walking, cycling, travelling by bus, etc) was calculated by using the mean score of the category. For example, the walking risk index score was calculated as a sum of scores on the five walking risk behaviour items, and then divided by five. To facilitate comparison, the index scores were categorised into groups of low, medium and high-risk behaviours, corresponding to the cut points of 75th percentile or lower, 75th to 90th percentile, and 90th percentile or higher, according to their frequency distributions. These cut points were chosen because the scores on all three risk behaviour indices were positively skewed, with most subjects reporting low-risk behaviour scores.

The Road Safety Knowledge Index included 14 items that measured knowledge and understanding of road safety rules. The road safety knowledge index was developed based on existing literature, materials from the national safety knowledge contest and materials used in several traffic safety education programmes.[17–19] Pilot tests were conducted with students, parents and school representatives before implementation. The respondents were asked to choose a correct answer for each of the 14 statements. Correct responses received a score of '1' and incorrect or missing responses received a score of '0'. The road safety knowledge index was calculated as the sum of responses divided by 14. The index score was categorised into categories of low, medium and high corresponding to the cut-off points of 35.5 percentile or lower, 35.5 to 67.1 percentile, and 67.1 percentile or higher, based on the negatively skewed frequency distribution of the knowledge scores.

Road traffic injury in this study was defined as any road traffic event that occurred in the past 12 months and that required medical attention or that restricted school participation for 1 day or longer. For students who sustained more than one injury, information on the most severe injury was collected.

Statistical analysis

Data were entered into a computer database using EPIdata V3.1 software. The number and characteristics of road traffic injuries were described including the severity of injury, injury type, medical attention received, activities at time of injury, injury recovery at 1 month and

psychological impact of the injury. Differences in demographic characteristics between injured and non-injured children were compared using χ^2 tests.

Logistic regression was used to assess the effects of road traffic risk behaviour and road safety knowledge on the odds of any road traffic injury in the past year, controlling for potential confounding variables. Interactions were assessed between knowledge and each of risk behaviour index (including cycling, walking and total). No interactions were found between knowledge and all risk behaviour index. All of the analyses were conducted using SPSS software (version 17.0).

RESULTS

Frequency and characteristics of injured children

Of 3747 participating students, 1918 (51.2%) were boys and 1812 (48.4%) were girls. The average age was 12.6 years, ranging from 9 to 19 years. A total of 403 (10.8%) students reported having at least one road traffic injury during the past 12 months, with 140 (34.7%) of them reporting more than one injury event (table 1).

Boys were 1.76 (95% CI 1.40 to 2.20) times more likely to report a road traffic injury than girls. Students in primary schools (grades 4–6) had a higher risk of injury compared with those in secondary schools (OR 1.32, 95% CI 1.03 to 1.71). Students who attended schools in suburban areas reported a higher risk of injury than those in urban areas (OR 1.37, 95% CI 1.09 to 1.72). Students who usually rode their bicycle to school had an increased risk of road traffic injury compared with those who walked to school (OR 1.92, 95% CI 1.39 to 2.65; table 1).

Cause and severity of injury

Riding a bicycle was the most common activity leading to an injury (46.0% of all injuries). Among these, approximately one third (n=54, 30.3%) reported that their bicycles collided with another bicycle, and approximately one quarter (n=43, 24.2%) reported collision with a motor vehicle. Compared with other mechanisms of road traffic injury, motor vehicle occupant injuries led to the worst outcomes, including a higher proportion of fractures and cranial/trunk injuries, increased hospitalisations and need for medical attention, and more severe psychological sequelae (table 2).

Road traffic injury by risk behaviour and road traffic safety knowledge

Lower levels of road safety knowledge were significantly associated with higher risk behaviours (table 3). Among students with a low knowledge index, 28.7% reported medium or high-risk behaviours. In contrast, only 19.5% of students with a high knowledge index reported medium or high-risk behaviours ($p<0.001$).

Increased road safety knowledge was a strong protective factor for road traffic injury (table 4). Compared with students with a high score on the knowledge index, the OR of road traffic injury for students with low and medium road safety knowledge scores were 2.93 (95% CI 2.18 to 3.93) and 1.53 (95% CI 1.11 to 2.11), respectively. Students with high scores on the risk behaviour index also had more than twice the risk of injury compared with students with

low-risk behaviour index scores (OR 2.04, 95% CI 1.47 to 2.84). In particular, students who scored high on walking risk behaviours had an increased odds for road traffic injury of 2.45 (OR 2.45, 95% CI 1.73 to 3.48). Students with high cycling risk behaviour scores also had an increased odds of road traffic injury (OR 1.84, 95% CI 1.23 to 2.74), compared with students who scored medium or low on the risky walking or cycling behaviour groups, respectively, (table 4).

DISCUSSION

This is one of a few studies to examine the associations among road traffic knowledge, risk behaviours and injuries among school children in China.[9–11] We found that approximately 10% of children will experience at least one road traffic injury each year, and more than 60% of these injured students require medical attention. We also found that safety knowledge is a significant protective factor for road traffic injury, while a higher level of risky traffic behaviour is associated with an increased rate of road traffic injuries. Developing culturally appropriate intervention programmes that target increased knowledge and reduced risk behaviours among children and parents is an important component of a comprehensive traffic safety programme.

Students from the suburbs of Guangzhou had a higher rate of road traffic injuries compared with students from urban areas. Our observed injury rate in suburban students (12.6% per year) was similar to the rate of 3.6% over a 3-month period found in a study conducted in a rural area of the Hunan province of China.[20] Although walking was most frequently reported as the main type of transportation, bicycling injuries were the most common. While types of transportation may be difficult to change, further intervention efforts should develop different strategies for all three types: walking because it is the most used, bicycling because it is the most frequent cause of injury, and motor vehicle occupant injuries because they are the most severe.

We found that children with highly educated mothers were more likely to report having an injury, which is consistent with the findings reported from several studies conducted in China.[21–23] In China, high educational status is strongly correlated with higher income, and children in higher income families often have more exposure to the traffic environment because they are more likely to attend school by walking, to walk to activities and to own a bicycle. Highly educated mothers may also be more likely to work, which could be tied to reduced supervision of their children when walking.

Consistent with previous study findings in other countries[24] we found that a lack of road safety knowledge is significantly associated with an increased rate of road traffic injuries among school children in China. Although safety education has received more attention in recent years in Chinese schools,[25] lessons on road traffic safety have been minimally taught in school. A survey conducted in 4623 middle school students in Beijing found unsatisfactory levels of student road safety knowledge, with an average score of only 64.1 (out of 100).[11] We also found poor road safety knowledge in our student sample. For example, 76.9% students did not know that riding a bicycle while carrying another person is an unsafe behaviour.

Several studies conducted in China revealed that road traffic risk behaviours among school children are quite common. A study conducted in Shanghai found that approximately 40.7% of Shanghai students violated traffic rules when crossing the streets, 48.4% of them violated traffic rules when riding a bicycle and 42.2% of them never or rarely wore a seatbelt.[26] Another survey found that 56.4% of students in primary schools frequently failed to use a seatbelt.[27] The results from our study show that students with a higher level of risky behaviour (such as not wearing a seatbelt, or violating traffic rules) are more likely to report a road traffic injury.

With a rapid increase in motor vehicle owners in China, comprehensive road traffic safety programmes are needed. Our findings, along with those from other studies, suggest that primary school education focused on knowledge and behaviour change, which integrates children, parents and the schools, is an important component of a comprehensive approach.[28–31] These programmes need to target not only students' knowledge, perceptions and behaviours, but also aim to improve the traffic conditions around the school environment effectively to reduce road traffic injuries in children.

Although this study provided a careful examination of the relationships between road traffic knowledge, risk behaviour and injuries, there are several limitations. The use of self-report data on road traffic risk behaviour and injuries may be subject to recall bias and socially desirable response bias.[32] Risky behaviour was assessed during the previous month, but the survey period of road traffic injuries was the previous year; they are not synchronous. However, we believe that risk behaviour over the past month can be viewed as an individual's exposure tendency and can also be associated accurately with the occurrence of road traffic injuries. Overall knowledge and behaviour indices were related to traffic events and injuries, respectively, but more research is needed to identify the specific behaviours that have the highest risk of injury. Finally, our findings were based on the students in Guangzhou City, which may not be generalisable to other parts of China.

CONCLUSION

Road safety knowledge is an independent protective factor for road traffic injury. Students with a high level of risky traffic behaviour are more likely to sustain road traffic injuries. Comprehensive intervention programmes including road safety knowledge education, strategy of behaviour change and environmental improvement are urgently needed in China.

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What is already known on this subject

- Road traffic injury is a leading cause of death for chīldrer around the world, particularly among children in developing economic countries.
- China has increasing rates of pedestrian road traffic injury.

What this study adds

- Over 10% of 3747 children in six primary and six middle schools in Guangzhou, China, reported a road traffic injury in the past 12 months.
- Bicycle injuries were the most common, while motor vehicle occupant injuries were the most severe.
- Low knowledge of road safety rules was associated with up to a threefold increase in reported road traffic injury.
- Students who reported risky road behaviours had twice the odds of reported road traffic injury.

Intelligent cars

Cars fitted with aircraft-style black boxes which can send video footage about driving behaviour during crashes to the police and insurance companies are being developed. 'The car will record information about the vehicle speed, steering and braking along with video footage from inside and outside the vehicle. This would be automatically sent to police and insurance companies in the event of an accident to make it easier to determine the cause of car crashes and identify the person responsible.' *The Daily Telegraph TGM* (CTVglobemedia Publishing Inc).

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Table 1

Demographic characteristics and odds of reported road traffic injury among 3747 students, Guangzhou City, China

		Injury (n = 403)		Non-injury (n = 3344)		
Variable	**N**	**n**	**%**	**n**	**%**	**OR (95% CI)†**
Sex	3730					
Male	1918	256	13.3	1662	86.7	1.76 (1.40 to 2.20)**
Female	1812	145	8.0	1667	92.0	Reference
Grade	3747					
Primary	1886	199	10.6	1687	89.4	1.32 (1.03 to 1.71)*
Secondary	1861	204	11.0	1657	89.0	Reference
Region	3747					
Urban	2100	195	9.3	1905	90.7	Reference
Suburban	1647	208	12.6	1439	87.4	1.37 (1.09 to 1.72)*
Living arrangement	3747					
Both parents	3133	317	10.1	2816	89.9	0.74 (0.56 to 0.97)*
Other situation	614	86	14.0	528	86.0	Reference
Mother's education (years)	3597					
≤12	2878	306	10.6	2572	89.4	0.95 (0.70 to 130)
13–16	623	59	9.5	5647	90.5	Reference
≥17	96	18	18.8	78	81.3	2.14 (1.18 to 3.91)**
Main transportation	3712					
Walking	847	73	8.6	774	91.4	Reference
Cycling	775	126	16.3	649	83.7	1.92 (1.39 to 2.65)**
Motor vehicle	947	114	12.0	833	88.0	1.36 (0.98 to 1.87)
Others	1143	83	7.3	1060	92.7	0.68 (0.47 to 0.99)*

*p Value <0.05 from χ^2 significance test,

**p value <0.01 from χ^2 significance test.

†Controlled OR from model: Y=sex + region + grade + living arrangement + main transportation + mother's education.

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Table 2

Characteristics of the most severe road traffic injury reported by students in Guangzhou City, China

			Activities of student in the most severe injury injuryevent							
	Total		Bicycle		Walk		Motor vehicle		Other	
	n	%	n	%	n	%	n	%	n	%
Total	387	100	178	46.0	103	26.6	91	23.5	15	3.9
Type of injury †										
Abrasion	273	70.5	139	78.1	72	69.9	55	60.4	7	46.7
Soft tissue injury injury/strain/sprain *	53	13.7	22	12.4	8	7.8	23	25.3	0	0.0
Fracture of bone	31	8.0	8	4.5	8	7.8	14	15.4	1	6.7
Dislocation	28	7.2	7	3.9	7	6.8	14	15.4	0	0.0
Head injury	10	2.6	1	0.6	2	1.9	7	7.7	0	0.0
Trunk iniury	7	1.8	1	0.6	2	1.9	3	3.3	1	6.7
Others	34	8.8	12	6.7	7	6.8	9	9.9	6	40.0
Medical assistance received *										
Yes	241	62.3	96	53.9	71	68.9	69	75.8	5	33.3
Surgery	8	2.1	1	0.6	4	3.9	1	1.1	2	13.3
Hospitalisation	26	6.7	6	3.4	8	7.8	12	13.2	0	0.0
Emergency department	127	32.8	50	28.1	36	35.0	38	41.8	3	20.0
School clinic	80	20.7	39	21.9	23	22.3	18	19.8	0	0.0
No	96	24.8	56	31.5	25	24.3	11	12.1	4	26.7
Others/missing	50	12.9	26	14.6	7	6.8	11	12.1	6	40.0
Recovery from injuries after 1 month *										
Recovery	253	65.4	127	71.3	69	67.0	48	52.7	9	60.0
Functional impairment	54	14.0	18	10.1	14	13.6	21	23.1	1	6.7
Pain	39	10.1	14	7.9	13	12.6	11	12.1	1	6.7
Missing	41	10.6	19	10.7	7	6.8	11	12.1	4	26.7
Psychological impaction *										
Severe impaction	27	7.0	10	5.6	4	3.9	13	14.3	0	0.0
Some impaction	110	28.4	45	25.3	34	33.0	27	29.7	4	26.7

	Total		Activities of student in the most severe injury injuryevent							
			Bicycle		Walk		Motor vehicle		Other	
	n	%	n	%	n	%	n	%	n	%
No impaction	234	60.5	117	65.7	61	59.2	46	50.5	10	66.7
Missing	16	4.1	6	3.4	4	3.9	5	5.5	1	6.7

*p Value <0.05 from χ^2 significance test.

†This item allowed the selection of multiple options.

Table 3

Relationship between the risk behaviour index and road safety knowledge index, 3747 school children in Guangzhou City, China

		Risk behaviour index							
		Low		Medium		High			
Group		**n**	**%**	**n**	**%**	**n**	**%**	**χ^2**	**p Value**
Knowledge index	3747							37.64	<0.001
Low	1893	1351	71.40	312	16.50	230	12.20		
Medium	1234	966	78.30	181	14.70	87	7.10		
High	620	499	80.50	72	11.60	49	7.90		

p Value <0.05 from χ^2 significance test.

Table 4

Risk behaviour index and road safety knowledge index associated with odds of reported road traffic injury among 3747 students, Guangzhou City, China

		Injury (n = 403)		Non-injury (n = 3345)		
Variable		**n**	**%**	**n**	**%**	**OR (95% CI)†**
Knowledge index	3747					
Low	1894	288	15.20	1606	84.80	2.93 (2.18 to 3.93)**
Medium	1234	93	7.50	1141	92.50	1.53 (1.11 to 2.11)**
High	620	22	3.50	598	96.50	Reference
Risk behaviour index—cycling	2049					
Low	1575	227	14.40	1348	85.60	Reference
Medium	285	45	15.80	240	84.20	1.06 (0.72 to 1.56)
High	189	47	24.90	142	75.10	1.84 (1.23 to 2.74)**
Risk behaviour index—walking	3684					
Low	2955	280	9.50	2675	90.50	Reference
Medium	439	58	13.20	381	86.80	1.65 (1.19 to 2.29)**
High	290	56	19.30	234	80.70	2.45 (1.73 to 3.48)**
Risk behavior index—total	3747					
Low	2816	266	9.40	2550	90.60	Reference
Medium	565	71	12.60	494	87.40	1.42 (1.05 to 1.93)**
High	366	66	18.00	300	82.00	2.04 (1.47 to 2.84)**

*p Value <0.05 from χ^2 significance test,

**p value <0.01 from significance test.

†Controlled for sex, region, grade, living arrangement, main transportation and mother's education.