Original Article

Nonfatal Child Pedestrian Injury in Two Urban Cities of Guangdong Province, China：Results from a Cross-sectional Survey

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Abstract

Objective To describe the epidemiological characteristics of nonfatal child pedestrian injuries and provide information to help understand an important public-health problem.

Methods This was a school-based, cross-sectional questionnaire survey. The sample (42 750 children) was obtained from two urban cities of Guangdong Province, China, using multi-stage randomized sampling. Information was collected by the respondents self-reporting in the classroom.

Results The incidence rate of nonfatal child pedestrian injuries in the cities was 2.0%. Boys had a higher incidence rate (2.6%) than girls (1.4%). Compared to other children, those aged 10 years are at the highest risk. The primary places of occurrence were sidewalks, residential roads, and crosswalks. High-risk behavior of the children immediately prior to injury included mid-block crossings, playing on roads, and crossing on red lights. The major vehicles that caused pedestrian injuries were bicycles, car or vans, and motorcycles. Bruises, fractures, and injuries to the internal organs were the top three types of injuries. Almost 40% of victims were hospitalized, and nearly 30% of the victims suffered long-term disabilities.

Conclusion This study shows that nonfatal child pedestrian injuries are a very serious public-health problem in the urban cities of Guangdong. Based on the epidemiological characteristics, prevention strategies and further research should be carried out to reduce the occurrence of injuries.

Key words: Children; Pedestrian; Injury; Cross-sectional study

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INTRODUCTION

Pedestrian injury is a major hazard to the health of children in most developed countries[1-3], and many studies have been devoted to this subject[1-4]. However, comparatively little attention has been paid to nonfatal pedestrian injuries in these industrialized countries.

Among other reasons, bad traffic conditions, weak law enforcement, and low traffic safety awareness make pedestrian injuries a much more serious problem in developing than in developed countries[3-4]. As the largest developing country, China has the highest number of traffic injuries in the world[5]. Pedestrian injuries are also a significant source of morbidity, mortality, and disability among children in China. Nonetheless, few academic studies have been conducted about this issue.

Guangdong Province is located in the south of China. Traffic injuries are a serious public-health problem in the province, and they account for more than one-tenth of all traffic deaths in China[6-7].

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Traffic injuries are a particularly serious problem in the urban cities of Guangdong Province, such as Guangzhou and Shenzhen, because of the high-density population, large numbers of children, and the rapidly increased traffic volume. Thus, it is necessary to conduct population-based studies to understand the epidemiological traits and relative risk factors of child pedestrian injuries in the province.

This study concentrates on nonfatal pedestrian injuries of children aged 6-15 years, using a cross-sectional survey design. The primary aims were to describe the epidemiological characteristics of nonfatal child pedestrian injuries and provide basic information to assist in developing prevention policies.

MATERIALS AND METHODS

Study Sites

Guangdong is one of the most developed provinces in the country. Traffic injuries are a serious public-health problem in the province and account for more than one-tenth of all traffic deaths in China[8]. Guangzhou is an important trading center as well as being the capital of Guangdong Province; Shenzhen is a coastal city, on the border with Hong Kong. According to police data, the deaths resulting from traffic injuries in these two cities account for more than 30% of all deaths from traffic injuries in Guangdong Province. Moreover, Ma[9] reported that the mortality from child pedestrian injuries in Guangzhou amounted to 17.6/100 000. Thus, Guangzhou and Shenzhen were selected as study sites in the present investigation.

Definition of Child Pedestrian Injury

Child pedestrian injuries have been defined as injuries caused by collisions between vehicles and pedestrians aged 6-15 years-whether on public streets and highways or on private property or other non-traffic locations[10]. The present investigation included only children with injuries that occurred in the year preceding the survey who sought medical services.

Subjects

A stratified random sample was selected from Guangzhou and Shenzhen. The sample size was calculated for a cross-sectional survey, and the total sample size was estimated to be 40 000 children. All respondents were selected from a pool of school students. The sampling procedures were completed as follows. First, every city is divided according to official definition into two types of districts-downtown and suburb districts; one downtown and one suburb district were randomly selected from each city. Then, lists of schools and their classification (according to education quality, every school is classified as “good,” “average,” or “below average” by the Education Department) were obtained from the education departments of the two cities; eight schools were selected by simple randomized sampling in each district for each school classification. In total, 96 schools were selected in the two cities for the survey. Finally, all students from grades 1 to 8 in the selected schools were taken as the subjects of the study. The total size of the sample was 42 750.

Of the 42 750 students, 42 109 (98.5%) returned their questionnaires; of these, 21 952 (52.1%) students were from Shenzhen and 20 157 (47.9%) from Guangzhou. The characteristics of the sample are presented in Table 1. The majority of the sample (61.8%) consisted of local residents registered in the two urban cities, and more than one-third were children from other provinces or other cities of Guangdong Province. Of the respondents, 60.1% reported being from families with a medium-level household income. Overall, the father’s education level tended to be higher than the mother’s. Most families (76.5%) had three to four members, and the most common family patterns were father + mother + respondent (25.2%) and father + mother + respondent + siblings (33.2%).

Measuring Instrument

This study took the form of a questionnaire survey. The questionnaire used was developed by the researchers based on a review of the literature[11-17]. A reviewing process and pilot study were carried out to test and refine the questionnaire and data-collection procedure prior to implementation. After the pilot study, minor modifications were made to the questionnaire. The socioeconomic status variables consisted of child’s age, gender, mother’s educational level, father’s educational level, family size, family income, and family pattern. Because it is not easy to obtain accurate data about family income, this study simply asked respondents to report their family economic status as “poor,” “medium,” or “wealthy” according to their own perceptions. The other variables, including the child’s personality, transportation mode, time spent traveling to school,

number of roads crossed, places of crossing roads, tendency to play on the roads, perception of walking safety, and number of times crossing roads unsafely, were considered as confounding factors.

Table 1. The Demographic and Socioeconomic Characteristics of the Sample

Characteristics	No. of Survey(%)	Characteristics	No. of survey(%)	Characteristics	No. of Survey(%)
Age(year)		***Gender***		***Family size***	
Missing	331(0.8)	Missing	51(0.1)	Missing	63(0.2)
6-7	5801(14.0)	Male	23347(55.4)	2	2647(6.3)
8	4212(10.0)	Female	18711(44.4)	3	12096(28.7)
9-10	8844(21.0)	***Father education***		4	20140(47.8)
11	4836(11.5)	Missing	197(0.5)	5	6393(15.2)
12	5054(12.0)	Below Secondary School	2771(6.6)	6	736(1.8)
13	6082(14.4)	Secondary School	10966(26.0)	7	34(0.1)
14-15	6869(16.4)	High School	13263(31.5)	***Family pattern***	
Total	42109(100.0)	Undergraduate	8962(21.3)	Single Father+Respondent	357(0.9)
Residence		Postgraduate	1597(3.8)	Single Mother+Respondent	1092(2.6)
Missing	359(0.9)	Unknown	4353(10.3)	Grandparents+ Respondent	503(1.2)
Local Children	26016(61.8)	***Mother education***		Siblings +Respondent	432(1.0)
Floating Children	15261(36.2)	Missing	197(0.5)	Father+Mother+ Respondent	10620(25.2)
Others(from Hong Kong or Foreign Countries)	473(1.1)	Below Secondary School	5593(13.3)	Father+Mother+Grand Parents+Respondent	4297(10.2)
Family income		Secondary School	12772(30.3)	Father+Mother+ Nanny+Respondent	752(1.8)
Missing	136(0.3)	High School	11207(26.6)	Father+Mother+ Siblings+Respondent	13963(33.2)
Wealthy	13422(31.9)	Undergraduate	7102(16.9)	Father+Mother+ Others+Respondent	563(1.3)
Middle Class	25289(60.1)	Postgraduate	796(1.9)	Others	9530(22.6)
Poor	1923(4.6)	Unknown	4442(10.6)		
Unknown	1339(3.2)				

Data Collection

The survey was conducted between June and August 2007 by trained professionals from the Center for Disease Control and Prevention in both Guangzhou and Shenzhen. Taking into consideration the young age of students in grades 1 to 3, anonymous questionnaires (though with a student code allowing the teacher to check the questionnaire) were distributed to the children in the classroom; the questionnaires were completed at home with the help of the children's parents and collected by the class teacher the following day. Teachers were trained in a one-hour workshop, during which they learned how to check whether respondents had omitted some items or made logical errors in completing the questionnaires. If a questionnaire had more than five items with missing values, it was immediately returned to the student for completion of the missing items. For students in grades 4-8, data were collected using a self-administered questionnaire, which was completed in the classroom. From the pilot study, this procedure was found to be feasible. Every student filled in the questionnaire anonymously (though with a student code allowing the teacher to check the questionnaire) under the instructions of interviewers and teachers. If any student had questions about filling in the questionnaire, interviewers were available to help. After students handed in their questionnaires, interviewers checked every questionnaire by way of quality control. Five investigators of the project visited 25 of the participating schools to supervise the fieldwork.

A letter was sent to students' parents to explain

the survey's aims before it was implemented. Before participating in the study, each student was asked to provide an informed consent form signed by their parents or supervisors. The use of anonymous questionnaires assured that the confidentiality of respondents was protected. The study protocol was approved by the ethics committee of the Center for Disease Control and Prevention of Guangdong Province.

Data Analysis

All completed questionnaires were sent to the Center for Disease Control and Prevention of Guangdong Province to be coded, inputed, and cleaned before analysis. To reduce entry errors, duplicate entries were made for all the questionnaires. Analysis was performed using the statistical software package SAS 9.13(SAS Institute Inc.,Carly, NC, USA). A χ^2 test was applied to a contingency table for testing the null hypothesis of independence of rows and columns.

RESULTS

Incidence Rate

The study identified 851 nonfatal child pedestrian injuries. Of these cases, 597 (70.2%) were males; 253 (29.7%) were females; in one case the gender details were missing. The incidence rate of nonfatal pedestrian injury for children aged 6-15 years was 2.0% (851/42 109). There was a higher incidence rate among boys (2.6%) than girls (1.4%) (χ^2=76.16, *P*<0.001). Grouped by age, a higher incidence rate was found in children aged 9 and 10 years (2.6% and 2.7%). Figure 1 shows the age distribution of incidence rates by gender. This figure shows that for every age, boys had higher rates than girls; the difference was greatest for the age of 11-12 years.

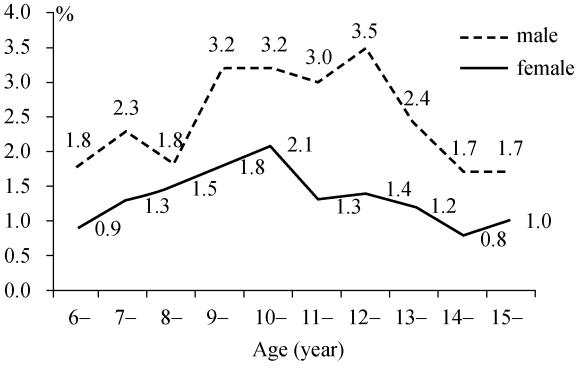

Figure 1. Incidence rates of nonfatal pedestrian injury by gender and age.

Time of Occurrence

Afternoon was the most dangerous time for child pedestrians, with 42.6% of injuries occurring at this time of day. The proportions occurring in the morning and in the evening were 22.2% and 17.3%, respectively. Approximately 18.0% of children could not remember the exact time of the incidents. There were no significant differences in time distributions of occurrence by gender (χ^2=2.86, *P*=0.41) or age-group (6-8 years, 9-12 years, 13-15 years; χ^2=34.08, *P*<0.001).

Places of Occurrence

Child pedestrian injuries primarily occurred at the following places: sidewalks (24.4%), residential roads (19.5%), crosswalks (14.1%), and city expressways (13.8%) (Figure 2). There were no significant differences in places of occurrence by gender (χ^2=4.93, *P*=0.67) or age-group (χ^2=19.35, *P*=0.15).

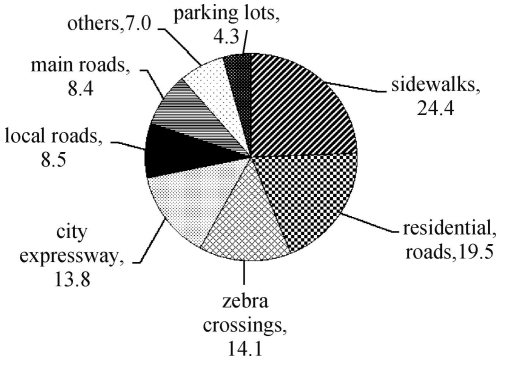

Figure 2. Percentage distribution of places of occurrence of pedestrian injury incidents.

Activities Prior to Injury

Of the incidents, 37.3% were caused by high-risk behavior on the part of children; this consisted of mid-block crossings (14.0%), playing on the roads (10.0%), crossing on red lights (9.2%), and climbing over isolation facilities on the roads (4.1%). Approximately 45% of children reported that they had not violated traffic regulations immediately prior to the incidents.

Type of Vehicle Involved

Motor vehicles caused 58.2% of all the nonfatal pedestrian injuries. The major vehicle types that resulted in pedestrian injuries were bicycles (26.3%), cars or vans (22.6%), motorcycles (19.0%), and tricycles (13.8%). There was no significant difference

in distribution of vehicle type by gender (χ^2=2.07, *P*=0.96). Although there was a significant difference among the age-groups (χ^2=25.75, *P*=0.015), the difference was small.

Nature of Injury and Body Region Injured

Almost half (49.8%) of the injuries were bruises. Fractures accounted for 14.6% of all injuries, and 7.2% of victims suffered injuries to the internal organs. There were no significant differences by gender (χ^2=11.80, *P*=0.67) or age-group (6-8 years, 9-12 years, 13-15 years; χ^2=17.28, df=12, *P*=0.14) .

The main regions of body injured were the lower limbs (25.5%), hands or feet (22.3%), and head or neck (11.5%). There was no significant difference by gender (χ^2=5.22, *P*=0.63). However, the proportion of head and neck injuries decreased with increasing age from 6–8 years and 9-12 years to 13-15 years (χ^2=10.26, *P*=0.0059), with the figures being, respectively, 24.0%, 17.3%, and 11.3%.

Treatment and Sequelae of Injury

Among the victims, 38.1% were hospitalized, and 61.9% received treatment only in the emergency department of the hospital. There were no significant differences in distribution of treatment by gender (χ^2=0.005, *P*=0.95) or age-group (χ^2=6.03, *P*=0.50). However, there was a significant difference in hospitalization distribution according to place of occurrence (χ^2=29.26, *P*=0.50). From Figure 3, it can be seen that there were higher proportions of hospitalization for pedestrian injuries occurring on city expressways (56.0%) and in parking lots (44.4%). Vehicle type was also a factor influencing hospitalization after injury. There was a higher proportion of hospitalization for pedestrian injuries involving trains and heavy trucks/public buses, which accounted for, respectively, 70.8% and 63.6%.

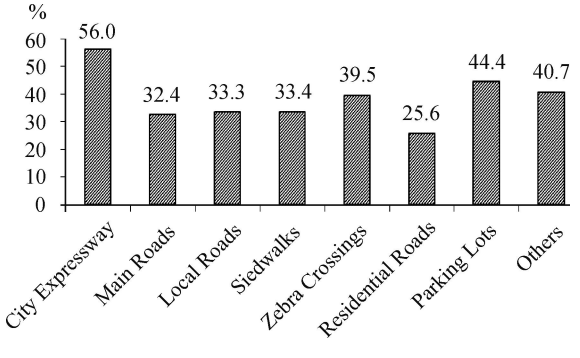

Figure 3. Distribution of hospitalization by place of occurrence.

Almost 30% (29.2%) of victims reported that pedestrian injuries caused long-term disabilities. Of these, 26.6% and 16.1% of children had, respectively, lower-limb and upper-limb disabilities; 26.1% refused to report their long-term outcomes. There were no significant differences in distribution of sequelae by gender (χ^2=0.339, *P*=0.843) or age-group (χ^2=7.26, *P*=0.123) .

DISCUSSION

Nonfatal pedestrian injuries are a very important public health issue for children in the western countries[14,18-20]. However, very few population-based studies have dealt with the incidence of nonfatal pedestrian injuries in those countries. Most studies have been based on data from health facilities or the police[2,14,21], though a major limitation of such data sources is underreporting[22-24]. In less developed countries, child pedestrian injury is a serious and under-recognized public-health problem; in particular, little has been established about child pedestrian injuries in China. To the authors' knowledge, the present research is the first population-based study to examine nonfatal pedestrian injuries among children in China.

This study found that the nonfatal pedestrian injury rate for children aged 6-15 years in urban cities of Guangdong Province was very high (2.0%) compared with other countries, such as the U.S., where the nonfatal pedestrian injury rates for children aged 5-9 years and 10-14 years were, respectively, 87.1/100 000 and 102.3/100 000[21]. This difference may be attributed to two reasons. The most significant reason may be that child pedestrians in Guangdong have a higher level of exposure to traffic and are at greater risk of injury owing to bad traffic conditions and the rapidly increasing volume of traffic. The other reason lies in differences in data-collection methods. The data in the U.S. derived from hospital emergency departments, whereas the present study is a population-based survey. Many studies that reported data from hospital emergency departments seriously underestimated the injury incidence because they did not include injured persons treated as outpatients or in other health-care facilities and those hospitalized without being treated in an emergency department[2,21].

A number of studies have demonstrated that among children, boys are more frequently injured as pedestrians in traffic than girls[4,25-27]. The present

research is consistent with these findings: we found that boys have almost twice the risk of suffering pedestrian injuries compared with girls. There are several explanations for the gender disparity in pedestrian injuries. First, boys tend to have more impulsive, uncontrolled behavioral styles that lead to higher risk for injury[28]. Second, boys are more likely to overestimate their physical ability and attribute injuries to bad luck, which can lead to more repeated injury-risk behavior than is the case with girls[29]. Third, societal expectations and gender-role socialization influence pedestrian-injury risk[30]. Boys are expected and permitted to take greater risks and to approach physical hazards more quickly and fearlessly[31]. Lastly, drivers tend to respect female pedestrians more than males by giving them greater opportunity to cross roads safely than they do for male pedestrians[12].

Age is a known risk factor for child pedestrian injury. This study found that children aged 10 years had the greatest risk of being injured in traffic as pedestrians. This result is similar to those of the studies conducted in France, the U.S., and Europe[2,21,32]. The probable reason is the confluence of developing mobility and underdeveloped cognition in children of this age. On the one hand, children of this age begin to show their mobility and independence without adult supervision. On the other hand, children of this age are not yet cognitively capable of simultaneously handling the several tasks required for safe pedestrian activity[28], and parents and the children themselves overestimate children's ability to cross streets and parking lots independently[33-34]. Sandels concluded that children under the age of 10 are incapable of behaving safely in complex traffic situations[35]. Therefore, although the teaching of street-crossing skills and safety rules, such as telling children to look both ways for oncoming traffic, may help prevent child-pedestrian collisions[36], other interventions, such as enhanced parental supervision and environmental changes (e.g. moving bus stop locations so that children do not have to cross the street after leaving the vehicle, constructing sidewalks, and placing barriers such as chains or fences to physically separate children from traffic), can be expected to yield a greater reduction in the number of pedestrian accidents involving children.

The literature reveals that children are typically injured in the morning and in the mid-afternoon. In the U.S. in 2006, 39% of young pedestrian (under age 16) fatalities occurred between 3 p.m. and 7 p.m.[19]. Yiannakopulias et al. reported that child pedestrian injuries occurred most frequently in the morning (07:00–09:00) and late afternoon (15:00–18:00)[37]. The present study found that the afternoon was the most dangerous time for child pedestrian injuries, with 42.6% of injuries occurring at this time. This may be explained by the convergence of children's peak pedestrian traffic (traveling home from school) and peak automobile traffic. A number of studies have found that the volume and density of traffic show a consistent relationship with increased risk of child pedestrian injury[20,38].

The present research indicated that the major places (accounting for 71.8% of injuries) for sustaining nonfatal pedestrian injuries among children were sidewalks, residential roads, crosswalks, and city expressways. These findings are different from those for fatal pedestrian injuries. For example, in the U.S., of all the pedestrian fatalities in King County, WA, 74% occurred on major thoroughfares; only 16% occurred on residential streets[39]. This indicates that for fatal and nonfatal pedestrian injuries the places of occurrence may be different. In the urban cities of China, restricting the use of motor or non-motor vehicles in residential areas and on sidewalks may be an effective countermeasure to reduce nonfatal pedestrian injuries. Thus, as an effective approach to preventing collisions between motor vehicles and pedestrians, changes in the traffic environment, such as to roadway barriers, pedestrian-crossing signs, and speed-limit measures, in the above injury hotspots should be considered[40-42].

With fatal child pedestrian injuries, some research has found that child pedestrian behavior on the roads, such as darting out in mid-block areas without warning and dashing across intersections, is an important risk factor[43]. The present study revealed that more than one-third of victims showed greater risk behavior immediately prior to the incidents. This behavior primarily included mid-block crossing, playing on the roads, crossing on a red light, and climbing over isolation facilities on the roads. Therefore, reducing children's risk behavior on the roads is a significant target in preventing childhood pedestrian injuries.

The vehicle type is a significant factor in influencing the occurrence and severity of pedestrian injuries[44-45]. The present study found that almost 60% of nonfatal pedestrian injuries were caused by motor vehicles. Of these, cars or vans and motorcycles were predominant, accounting for

71.5% of all motor vehicle injuries. Among non-motor vehicles, bicycles and tricycles were the main types of vehicles. Thus, this finding suggests that pedestrian injuries may be reduced by alterations to vehicle design and enhancing traffic management in the urban cities of Guangdong.

This study showed that majority of nonfatal pedestrian injuries were slight and required treatment only in emergency departments in the urban cities of Guangdong. However, almost one-third of victims suffered disabilities as a result of these incidents. This study also revealed that the principal regions of the body injured were the lower limbs, upper limbs, and head or neck; head injuries prevailed in the younger age-groups and decreased steadily with age. Other studies have reported that in severely injured patients, 60% to 79% have head injuries, and deaths from pedestrian injury were usually the result of head trauma[43].

CONCLUSIONS

The present study showed that nonfatal child pedestrian injuries are a very serious public-health problem in the urban cities of Guangdong Province. The injuries lead to hospitalization and disabilities. Motor vehicles played a more important role in severe child pedestrian injuries than non-motor vehicles. The violation of traffic regulations by the children immediately prior to the injury incidents is a high-risk behavior. This study suggests that integrated prevention strategies should be initiated to decrease child pedestrian injuries.

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