Evaluation of a School-Based Intervention to Reduce Traffic-Related Injuries among Adolescents in Beijing

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Abstract

Objective: Millions of adolescents are killed or injured in traffic accidents on the world's roads each year, but data on traffic-injury prevention programs targeting adolescents are limited, especially from developing countries. The aim of the study was to evaluate the effectiveness of a traffic-injury prevention program targeting adolescents in China.

Methods: We conducted a school-based traffic-safety intervention program with 2,759 students in two middle schools and two high schools in Beijing. An open-cohort, pre–post design with intervention and control groups was used to evaluate the intervention effect.

Results: Compared with the control group, the intervention group reported a significant increase in knowledge and awareness of traffic safety and a decrease in self-reported unsafe traffic behaviours.

Students in middle school and girls reported better intervention effects than their high school and male counterparts.

Conclusion: This study suggests that school-based traffic-injury prevention programs may increase participants' knowledge of traffic signs and awareness of traffic safety issues. The high traffic mortality in China, particularly in Chinese adolescents, suggests that more age- and culture-appropriate traffic safety promotion programs are needed.

Introduction

Each year, 1.2 million people are killed in traffic accidents worldwide (Peden et al. 2004). According to the World Health Organization (WHO), road traffic accidents constituted the ninth most frequent cause of death in 2004 and will rise to fourth by 2030 (WHO 2008). Almost half of traffic-related deaths are in "vulnerable road users" (i.e., pedestrians, cyclists or motorcyclists). Among these populations, children and adolescents are more vulnerable than adults. Traffic accidents are the second leading cause of death for children aged five to 15 years, and the number one killer for adolescents and adults aged 15 to 29 years (WHO 2008).

Despite the high rates of traffic-related mortality and morbidity in vulnerable road users, especially in children and adolescents, few studies evaluate interventions to improve road traffic safety among this younger group. Traffic safety interventions targeting adolescents focused mainly on reducing teenagers' risky driving habits (Duperrex et al. 2002). Reports on a small number of interventions on adolescent vulnerable road users showed positive effects of school-based interventions. For example, Hotz et al. (2004) reported that a school-based pedestrian-safety intervention program had improved knowledge of traffic safety and increased observable safe traffic behaviours among school children. Martinez et al. (1993) reported a school-based education outreach program in the United States (US) that had helped students identify traffic hazards, resulting in decreased self-reported unsafe traffic behaviours. However, all these studies have been conducted in developed countries, and there is a lack of evaluation studies on interventions to reduce traffic injuries in developing countries, particularly interventions targeting adolescent vulnerable road users. Furthermore, studies on traffic-related injuries in developing countries are mainly descriptive, with few interventions (Cai et al. 2008; Jing et al. 2008).

China hosts less than 2% of vehicles worldwide but accounts for 15% of traffic-related deaths (Li 2005). Over the past 50 years, road traffic accidents in China have increased by a factor of 68, from 6,000 in 1951 to 413,000 in 1999 (Wang et al. 2003). Vulnerable road users suffered more than half of traffic-related deaths; 26% were pedestrians, 9% cyclists and 28% motorcyclists (Wang et al. 2003; WHO 2009). Road traffic injury has become a leading cause of death for people aged one to 44 years and the leading cause of death for children under 14 years (China Ministry of Health 2000; Safe Kids Worldwide 2009). From 2000 to 2004, pedestrians and cyclists incurred 88.3% of morbidity and mortality caused by traffic accidents (Thein and Lee 1993). Some studies have indicated that the injury rate among males is higher than among females (Li and Baker 1997). However, few have examined the gender difference in traffic-related behavioural interventions.

Economic growth has accounts for an increasing number of motor vehicles in China over the past two decades. Provinces and areas in China have experienced different degrees of motorization. Beijing's grew more rapidly than any other. In 1990, the Beijing motorization index (vehicles per 1000 people) was 42.43, increasing to 111.28 in 1999 (Wang et al. 2003). With rapid motorization, road traffic mortality soars. In 1990, the mortality rate due to road traffic accidents in Beijing was 4.32 per 100,000; in 1999, it had increased to 11.95 per 100,000 (Wang et al. 2003).

In response to the skyrocketing number of traffic accidents, in 2003 the Chinese legislature passed the first road traffic safety laws, including speed limit, safe driving, and motorcycle helmet laws (Passmore and Ozanne-Smith 2006; WHO 2009). These laws had some effect, but it was limited by insufficient enforcement. The WHO reported that in 2006, the mortality rate from traffic accidents in China had decreased from nine deaths per 100,000 in 2001 to seven per 100,000 in 2006 (WHO 2009).

Despite the gloomy numbers, few interventions have been conducted to improve traffic safety behaviours among vulnerable road users in China, and there is a further paucity of studies evaluating interventions targeting adolescents. To fill this literature gap, in our study we evaluated a school-based intervention program targeting adolescents in Beijing. Our comprehensive program aimed to improve their knowledge and awareness of traffic safety.

Methods

Study Site

We conducted our study in Chaoyang District, Beijing. Beijing, the capital city of China, has experienced a dramatic increase in the number of motor vehicles as well as traffic accidents. The number of registered vehicles has increased from less than one million in 1997 to almost four million in 2009. More than 1900 new vehicles are registered every day in Beijing (Beijing Public Service Radio 2009; Kong 2005).

Chaoyang District is the largest and most populated in Beijing, with a population of more than three million, including two million permanent residents (people with Beijing household registration) and one million migrants (Chaoyang District Government 2007). We chose Chaoyang District as our study site because of its diverse population and variety of social classes.

Traffic injuries and deaths have become a major public health issue in Beijing. In 2006, there were 5,808 traffic accidents, with 1,373 deaths and 6,681 injuries due to these accidents. Direct costs of these accidents were more than 4 million Canadian dollars (China Statistical Yearbook 2007). Children and adolescents are disproportionately affected. A study conducted in Beijing showed that traffic injury was one of the three leading causes of death among adolescents 12 to 17 years old (Zeng 2006). The incident rate was 2.41% among 10- to 15-year-olds, and 1.96% among 15- to 17-year-olds. The majority of children and adolescents injured or killed in traffic accidents were vulnerable road users: 28.6% were pedestrians and 57.1%, cyclists (Zeng 2006). A study that analyzed accident locales revealed that 32% of traffic accidents involving elementary and middle school students in Beijing took place between the home and school (China Education News 2007).

Study Population and Study Design

The Institute of Health Education in the Beijing Center for Disease Control and Prevention (Beijing CDC) conducted the school-based intervention program. Of 83 middle schools and high schools in Chaoyang District, we randomly selected two middle schools and two high schools to participate. We randomly assigned one middle school and one high school to the intervention group and the others to the control group. As the schools were geographically dispersed, the chance of contamination was minimal. To reduce the burden on students, we randomly selected only a subset to complete the baseline and follow-up surveys. A total of 2,759 students participated in the study, including 1,473 (689 middle school students – 399 in the intervention and 290 in the control group, and 784 high school students – 377 in the intervention and 407 in the control group) at baseline, and 1,286 (695 middle school students – 413 in the intervention and 282 in the control group, and 591 high school students – 376 in the intervention and 215 in the control group) at follow-up. We used the same questionnaire in the baseline and follow-up surveys. The intervention was delivered to all students in participating schools between September 2005 (at the beginning of the semester) and February 2006 (before the end of the same semester). Students involved in the council were excluded from sampling for pre–post surveys. We obtained oral permission from students and their parents before the baseline and intervention program. Students completed the baseline and follow-up surveys anonymously in their classrooms. The study protocol received IRB approval from Beijing CDC.

Intervention Program

Prior to initiation of the study, the Institute of Health Education in the Beijing CDC organized a community council to advise on program development, implementation and evaluation. The community council included parents, teachers, local police officers, health educators and a

psychologist. With inputs from students and the community council, we developed a comprehensive school-based intervention program that included a formal in-class education curriculum; workshops involving parents, community members and traffic police; posters, flyers, first-aid training and a creative Flash design contest (students designed animated short films on the theme of traffic safety with Adobe Flash software). Most of the education curriculum was delivered in health education classes, which are weekly 90-minute classes. The intervention lasted for one academic semester (September 2005 to February 2006). Each grade was delivered the same core information but in age-appropriate formats. The program was delivered to the intervention group after the baseline survey and to the control group after the intervention group's follow-up survey. Students completed a baseline survey one week before the intervention and a follow-up survey after completion of the intervention. The response rate was as high as 99%.

Measurements

The questionnaire used in the baseline and follow-up surveys took about 15 minutes to complete and contained the following components: Part One assessed participants' demographic information, including age, gender, everyday commuting methods and daily commute time. Part Two focused on knowledge of traffic signs, including four questions with pictures of traffic signs. The total score ranged from zero to 4, with a higher score indicating greater knowledge. Part Three assessed awareness of traffic safety. Students were asked to judge the safety of 12 traffic behaviours, such as riding a bike on the sidewalk. The total score in this section ranged from zero to 12, with a higher score indicating greater knowledge and awareness of traffic safety. Part Four contained 11 questions to assess the student's recent self-reported unsafe traffic behaviours, such as riding a bike without a helmet. The total score was obtained by summing the 11 items, with a higher score indicating more unsafe traffic behaviours.

Data Analysis

We conducted the following data analysis to evaluate the effectiveness of the intervention program. First, we used Chi-square (for categorical variables) and a t-test (for continuous variables) to compare the differences between the intervention and control groups at baseline in demographic characteristics and key outcome variables (knowledge of traffic signs, awareness of traffic safety and self-reported unsafe traffic behaviours). Second, we performed Chi-square and a t-test to compare the differences in baseline and follow-up in key outcome variables in the intervention and control groups. The pre–post differences were depicted in graphs. Finally, we used a t-test to compare the intervention effects on gender and in different schools (middle school vs. high school); pre–post differences were also calculated.

Results

At baseline, 776 students in the intervention group and 697 students in the control group completed the survey. Their demographic characteristics, knowledge of traffic signs, awareness of traffic safety and self-reported unsafe traffic behaviours are described in Table 1. Compared with the control group, the intervention group had a slightly higher proportion of middle school students (51.4% in the intervention group vs. 41.6% in the control group) and more female students (53.0% in the intervention group vs. 47.8% in the control group). The most popular modes of commuting were public transportation, cycling and walking. More than half of students spent less than 30 minutes commuting (one way) every day. Students in the control group were less knowledgeable about traffic signs but showed a higher level of awareness of traffic safety and self-reported unsafe traffic behaviours.

After the intervention, the intervention group reported greater knowledge of traffic signs, greater awareness of traffic safety and fewer self-reported unsafe traffic behaviours (see Figure 1 for pre–post differences in the intervention vs. control group). All changes in key outcome variables were significant. For example, adolescents in the intervention group reported a significant increase in knowledge of traffic signs, from 2.84 to 3.31 in middle school and from 2.89 to 3.11 in high school,

compared with the control group, whose knowledge increased from 2.31 to 2.35 in middle school and from 2.82 to 2.84 in high school. The intervention group also reported a greater increase of awareness in traffic safety – from 7.43 to 9.5 in middle school and from 7.53 to 8.57 in high school vs. from 6.51 to 6.52 in middle school and from 8.92 to 7.74 in high school in the control group. The intervention group reported a decrease in self-reported unsafe traffic behaviours, from 2.13 to 1.75 in middle school and from 2.14 to 1.70 in high school, whereas the control group reported an increase in self-reported unsafe traffic behaviours, from 2.3 to 2.41 in middle school and from 2.23 to 2.63 in high school.

Table 1. Demographic characteristics and key indicators at baseline, comparing intervention and control groups

	Intervention group *n* = 776		Control group *n* = 697		
	n	%	*n*	%	*P*-value
Grade					
Middle school	399	51.4%	290	41.6%	0
High school	377	48.6%	407	58.4%	
Gender					
Male	365	47.0%	364	52.2%	.047
Female	411	53.0%	333	47.8%	
Commuting methods					
Walk	164	21.1%	104	14.9%	0
Bike	284	36.6%	306	43.9%	
Public transportation	274	35.3%	263	37.7%	
Private vehicle	45	5.8%	21	3.0%	
Others	9	1.2%	3	0.4%	
Commuting time (one way)					
<0.5 h	386	49.7%	390	56.0%	.056
0.5–1 h	251	32.3%	187	26.8%	
1–1.5 h	92	11.9%	88	12.6%	
1.5–2 h	25	3.2%	22	3.2%	
>2 h	20	2.6%	10	1.4%	
Had traffic injury last year	37	34.6%	47	39.5%	.747
Knowledge of traffic signs, mean (SD)	2.87 (1.010)		2.610 (1.064)		.000
Awareness of traffic safety, mean (SD)	7.48 (3.666)		7.92 (3.541)		.020
Unsafe traffic behaviours, mean (SD)	2.130 (2.717)		2.260 (2.594)		.360

SD = standard deviation.

Figure 1. Changes in baseline vs. follow-up in key outcome variables: comparing intervention and control groups

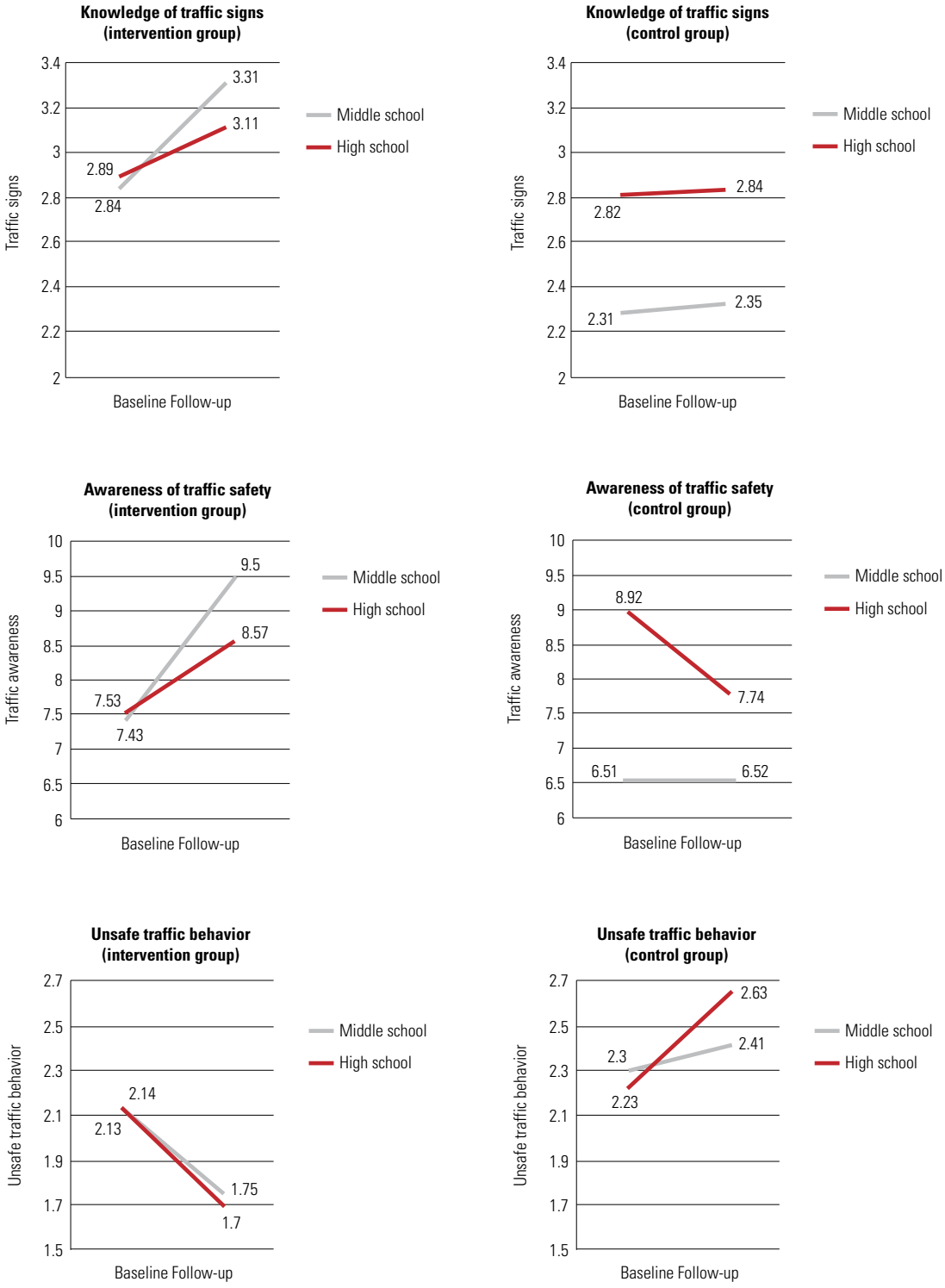

Table 2 depicts the intervention effect at different schools and in genders. The intervention had more effect in middle school than in high school students in improving knowledge of traffic signs and awareness of traffic safety. The intervention had more effect in high school than in middle school students in reducing self-reported unsafe traffic behaviours. There were also gender differences in the intervention effect. Girls and boys reported a similar increase in knowledge of traffic signs (0.32 vs. 0.38), but girls reported a greater increase in awareness of traffic safety (1.85 vs. 1.27) and a greater decrease in self-reported unsafe behaviours (-0.6 vs. -0.17). The control group reported minimal change in key outcome variables, except in awareness of traffic safety. The high school students and girls reported a lower level of awareness of traffic safety in the follow-up survey compared with the baseline survey.

Table 2. Intervention effect by grade and gender

		Knowledge of traffic signs mean (SD)			Awareness of traffic safety mean (SD)			Unsafe traffic behaviours mean (SD)		
		Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
Intv	**MS**	2.84 (1.01)	3.31 (0.92)	0.47* (-0.1)	7.43 (3.70)	9.50 (2.98)	2.07* (-0.72)	2.13 (2.65)	1.75 (2.36)	-0.38* (-0.29)
	HS	2.89 (1.01)	3.11 (0.95)	0.22* (-0.06)	7.53 (3.63)	8.57 (3.79)	1.04* (0.16)	2.14 (2.79)	1.70 (2.41)	-0.44* (-0.38)
	Girls	2.85 (1.01)	3.17 (0.97)	0.32* (-0.04)	7.56 (3.69)	9.41 (3.19)	1.85* (-0.50)	1.93 (2.45)	1.33 (1.86)	-0.6* (-0.59)
	Boys	2.89 (1.01)	3.27 (0.90)	0.38* (-0.11)	7.38 (3.64)	8.65 (3.63)	1.27* (-0.01)	2.36 (2.98)	2.19 (2.80)	-0.17 (-0.18)
Cntl	**MS**	2.31 (1.09)	2.35 (1.02)	0.04 (-0.07)	6.51 (3.74)	6.52 (3.80)	0.01 (0.06)	2.30 (2.51)	2.41 (2.43)	0.11 (-0.08)
	HS	2.82 (1.0)	2.84 (1.05)	0.02 (0.05)	8.92 (3.02)	7.74 (3.79)	-1.18* (0.77)	2.23 (2.65)	2.63 (3.26)	0.4 (0.60)
	Girls	2.49 (1.10)	2.52 (1.06)	0.03 (-0.03)	8.26 (3.39)	7.35 (3.78)	-0.91* (0.39)	1.69 (2.12)	1.99 (2.27)	0.3 (0.14)
	Boys	2.72 (1.02)	2.60 (1.05)	-0.12 (0.03)	7.60 (3.65)	6.80 (3.87)	-0.8* (0.22)	2.78 (2.86)	2.95 (3.15)	0.17 (0.28)

Intv = intervention group; Cntl = control group; MS = middle school; HS = high school; SD = standard deviation; Diff = difference.
*$p < .005$

Discussion and Conclusion

The current study provides evidence that a school-based traffic-safety intervention significantly increased adolescents' traffic knowledge and traffic safety awareness, and reduced their unsafe traffic behaviours. Most adolescents in the current study walked or cycled to school (60%). About 35% used public transportation for commuting, although they still needed to walk from home or school to a bus stop or subway station. Most adolescents in China are vulnerable road users. Given the very high mortality rate in vulnerable road users in China, especially in adolescents, interventions to reduce traffic accidents are urgently needed.

Our data also reveal that younger students (i.e., middle school students in the current study) experienced a greater increase in knowledge gain and awareness than older students. Such findings are consistent with other studies conducted in developed countries (Hotz et al. 2004). The data also indicate that girls were more responsive to the intervention than boys. Therefore, when we design

intervention programs to prevent traffic accidents in adolescents, we need to consider age and gender differences. Programs can begin early in the adolescent years and be reinforced throughout the middle school and high school years.

A number of limitations exist in the current study: (1) We employed an open-cohort design. Our intervention was implemented for all students in the participating schools, but only a small portion of students completed the baseline or follow-up survey. Such design was intended to minimize the disturbance of school operations and reduce the students' burden in doing surveys. (2) Our intervention was a comprehensive educational and outreach program that incorporated the active involvement of parents, teachers, traffic police and community members, but our surveys did not measure the intervention effects in these key stakeholders. (3) Our brief surveys focused only on students' knowledge and awareness of traffic safety and their self-reported unsafe traffic behaviours; students' traffic accidents were not included. Furthermore, as we used self-reports of unsafe traffic behaviours in our study, there might be a self-report and social-desirability bias. Observed behaviours are more desirable in such behavioural interventions. (4) Like all other health education interventions, participants were aware of the purpose of the intervention. Consequently, there might be testing effects and social-desirability bias in the survey responses. (5) Sample sizes in the intervention and control groups were different; such differences were due to different sizes of participating schools. (6) Awareness of traffic safety and unsafe traffic behaviours precipitously decreased and increased, respectively, among students in the control group. Our study could not provide evidence-based explanations for this finding, and it deserves further study. In addition, due to the relatively short time frame of the current study, we were not able to observe whether the increased traffic knowledge and awareness as well as decreased unsafe behaviours translated to fewer traffic accidents. However, available literature suggests that better traffic-related knowledge and fewer unsafe traffic behaviours are strongly correlated with fewer traffic accidents (Thein and Lee 1993). And finally, our study was conducted in two schools in the Chaoyang District of Beijing; findings may not be generalizable to adolescents in other middle schools and high schools in Beijing or other areas of China.

Despite these limitations, the study reports on one of the first school-based traffic-safety interventions targeting adolescents in China, and it demonstrates the effectiveness of the intervention program. After the pilot evaluation in Chaoyang District, the program was scaled up to all other schools in the Beijing municipal area. More research is needed to promote culturally appropriate traffic-injury prevention programs for adolescents in China.

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