Available online at www.sciencedirect.com

Public Health

journal homepage: www.elsevier.com/puhe

Original Research

Prevalence of drink driving and speeding in China: a time series analysis from two cities☆

Q. Li [a,*], H. He [a], L. Duan [b], Y. Wang [b], D.M. Bishai [a], A.A. Hyder [a]

[a] Johns Hopkins International Injury Research Unit, Department of International Health, Johns Hopkins Bloomberg School of Public Health, USA

[b] Injury Prevention Division, National Center for Chronic and Non-Communicable Disease Control and Prevention (NCNCD), Chinese CDC, Beijing, China

ARTICLE INFO

Article history:
Received 1 April 2016
Received in revised form
21 November 2016
Accepted 30 November 2016

Keywords:
Road safety
China
Speeding
Drink driving

ABSTRACT

Objectives: To confront the public health challenge imposed by road traffic injuries in China.

Study design: A consortium of international partners designed and implemented targeted interventions, such as social media campaigns, advocacy for legislative change and law enforcement training, to reduce the percentage of drink driving and speeding in two Chinese cities, Dalian and Suzhou, from 2010 to 2014.

Methods: Time series models were developed to detect changes in the prevalence of drink driving and speeding using data collected through four years of observational studies.

Results: This analysis, based on 15 rounds of data, shows that from May 2011 to November 2014, the percentage of vehicles driving above the speed limit decreased from 31.8% (95% confidence interval [CI]: 29.2–34.5) to 7.4% (95% CI: 7.0–7.9) in Dalian and from 13.5% (95% CI: 11.7–15.5) to 6.9% (95% CI: 6.4–7.4) in Suzhou. Drink driving decreased from 1.7% (95% CI: 1.1–2.4) in January 2011 to 0.5% (95% CI: 0.2–0.9) in November 2014 in Dalian and from 6.4% (95% CI: 5.4–7.4) to 0.5% (95% CI: 0.1–2.4) in Suzhou during approximately the same period. Time series models confirmed declining trends in both risk factors in both cities (*P*-value: 0.06 for speeding prevalence in Suzhou; all other *P*-values are below 0.05). Disaggregated by vehicle type, saloon cars and SUVs were more likely to exceed the posted speed limit than other types of vehicles in both cities. The speeding rate was higher where the posted speed limit is lower. In Dalian, more drivers were driving above the posted speed limit on weekdays than on weekends (11.4% vs 6.8%); Suzhou had a similar pattern, but the difference was smaller (14.0% vs 12.2%).

Conclusion: Despite the challenge in accurately attributing the observed changes to one programme, the substantial reduction in the prevalence of the two risk factors suggests that through coordinated actions, internationally recognized best practices in road safety may be effective in improving road traffic safety in China.

☆ Open Access provided for this article by the Johns Hopkins International Injury Research Unit through a grant from Bloomberg Philanthropies.

* *Corresponding author*. Bloomberg School of Public Health, Johns Hopkins University, 615 North Wolfe Street #E8642, Baltimore, MD 21205, USA.

E-mail address: qli28@jhu.edu (Q. Li).

http://dx.doi.org/10.1016/j.puhe.2016.11.024

Introduction

Road traffic injuries (RTIs) are a serious public health challenge in China, where, according to the estimates from the World Health Organization (WHO), more than 250,000 people die of RTIs annually.[1] It is the seventh leading cause of death in China, and there are more than 1.5 million adults living with permanent disabilities resulting from road traffic crashes.[2,3] Disability caused by RTIs is prevalent in China, particularly among males in rural areas.[4] The national government has undertaken a series of measures in the past decade to address road safety, including passing new laws and legislation, establishing coordination groups, improving data collection systems and funding safety programmes.[5] For example, enacted in May 2011, the amended Law of China on Road Traffic Safety substantially toughened the penalty for 'driving after drinking alcohol' and 'driving while intoxicated,' increasing the fine 5–10 times and length of driving licence suspension from 1–3 months to 6 months for the former violation. The latter violation was for the first time escalated to a criminal offence and subject to criminal responsibilities according to the Eighth Amendment to the Criminal Law of China.

Drink driving and speeding are two important risk factors in China causing a large number of crashes each year.[6] According to the annual bulletin of road traffic crashes of China, published by the Ministry of Public Security (MPS), speeding caused 7049 crashes, 3210 deaths and 6971 injuries in 2013.[7] In that year, drink driving caused 5174 crashes, 2288 deaths and 5303 injuries. Findings based on local data show a similar burden across the country. For example, a study of 765 drivers killed by RTIs in Shanghai during 2009–2011 found that 28.9% of them had a blood alcohol concentration (BAC) above 20 mg/100 ml and 21.8% were above 80 mg/100 ml.[8] Jia et al.[9,10] conducted several studies in Yinchuan and Guangzhou and found evident alcohol misuse among convicted offenders and low level of knowledge about legal BAC limits.

The clear need for concerted action in China to address these two risk factors in particular resulted in China's inclusion in the Global Road Safety Programme, a consortium of international partners funded by Bloomberg Philanthropies.[11,12] The programme strategy was to adopt internationally recognized best practices to improve road safety in selected countries and cities.[13] To our knowledge, this was one of the few road safety projects in China that involved both international partners and domestic stakeholders.[14] Based on a series of consortium meetings with project partners, the Global Road Safety Programme chose Dalian and Suzhou as the intervention cities in China, and speeding and drink driving as the two risk factors. Both cities have a large population of drivers and residents. In 2014, Dalian had a population of 6.7 million, of whom 1.9 million were drivers; the population of Suzhou was 10.1 million with 2.1 million drivers.[15] International partners included WHO, Johns Hopkins International Injury Research Unit (JH-IIRU), the World Bank Global Road Safety Facility (WB) and the Global Road Safety Partnership (GRSP).

The Chinese domestic road safety programme team was led by the National Health and Family Planning Commission (NHFPC) with a national project office at the Chinese Center for Disease Control and Prevention (China CDC). Dalian and Suzhou had city project offices that involved local CDC and traffic police. A vice-mayor of each city served as the head of the local project team. The main intervention components included between 2010 and 2014 were: (1) social marketing campaigns to increase the awareness of road traffic safety issues, particularly the adverse consequences of speeding and drink driving; text, audio and video messages designed by professional teams were distributed through posters, Internet and radio/TV programmes. Considerable effort was made to increase the coverage and effectiveness of the messages. (2) promotion of strengthening law enforcement on speeding and drink driving. A series of training and workshops were organized for traffic police to improve their enforcement skills. (3) Advocating for amendments to road safety-related legislation. Project partners presented a large number of evidence-based reports to law makers in both cities. Collaborating with law experts from prestigious law schools, the project's legal team hosted several high-level consultation meetings focussing on revising existing laws/regulations and making new regulations about emerging challenges, such as the rising epidemic of electronic bike related crashes and injuries. (4) Capacity-building of law enforcement officers, health professionals and leaders in each city. During the project period, biannual conferences were convened to update the city leadership, followed by capacity trainings designed for leaders including vice-mayor, commissioners of traffic police, health and transportation departments.

Between 2010 and 2014, the impact of these activities on drink driving and speeding behaviours was evaluated through roadside surveys and observational studies; the overall effect of the programme on reducing road traffic injuries and deaths was also assessed. The evaluation helped to assess the road safety status, guide the intervention design and monitor progress towards the goals of reducing risk factors and preventing road traffic injuries and fatalities. The goal of this paper is to assess the changes in road safety in the two intervention cities during the project period 2010–2014. Specific objectives are to (1) present data from observational studies on the prevalence of both risk factors; (2) summarize the achievements and limitations of the project; and (3) discuss the generalisability of the project interventions to improve road safety in China.

Methods

This paper measured the trends in prevalence of drink driving by conducting observational studies in conjunction with ongoing police enforcement activities in the two cities. Police conducted regular enforcement activities in sites close to bars, restaurants and other places where alcohol consumption usually occurs or in road sections with high traffic volumes. First, roadblocks were set up to stop vehicles; then breathalysers were administered to measure BAC levels of vehicle drivers. Trained researchers from local CDC offices recorded the number of drivers stopped, the number of drink driving drivers (defined as those with BAC between 20 mg/100 ml and

80 mg/100 ml) and the number of drunk drivers (defined as BAC above 80 mg/100 ml). Due to the small number of drunk drivers, we simplified the definition and have only used drink driving (BAC above 20 mg/100 ml) in the present study.

The prevalence of speeding was measured by conducting periodic observation studies at seven sites in each of the two cities. A simple random sampling method was used to select observation sites from a sample frame covering all possible observational sites in the city. The sites were picked to allow for a range of road types (urban and peri-urban, varying speed limits, divided and undivided) and geographic locations. At each site, three trained researchers from the CDC and one police officer used speed measurement devices to record speeds of all vehicles during a 90-minute period of time. Local CDC observers worked with police in order to comply with local road laws and for safety. In Suzhou, all measurements were conducted using police-owned, tripod-mounted radar speed measurement devices and video recorders that transmitted speed and images wirelessly to researchers at a remote location a short distance away. Since the observations would not be used for enforcement, no signs were required for the measurement and the devices were nearly invisible to drivers. This arrangement allowed the observers and police vehicles to be concealed from drivers in the measurement process, minimising the influence of observation on driver behaviour. In Dalian, data collections were conducted from inside a police car also using a radar speed measurement device.

A total of 15 rounds of measurements were conducted for each risk factor in each city between 2010 and 2014. Time trends were constructed to illustrate the changes in the prevalence of speeding and drink driving in the intervention cities. For each round of observation, we estimated the prevalence of speeding and drink driving, using confidence intervals (CIs) to account for sample errors. Statistical tests regarding the significance of changes in the prevalence of risk factors observed over the five-year period were also conducted.[16] Additionally, we developed time series models to account for the autocorrelation among the observations. Our model is a first-order autoregressive moving-average process.

$$y_t = \alpha + \rho * y_{t-1} + \theta * \varepsilon_{t-1} + \varepsilon_t$$

where y_t is the outcome in question at time t, ρ is the first-order autocorrelation parameter, θ is the first-order moving-average parameter, and $\varepsilon_t \sim i.i.d.N(0, \sigma^2)$ is a white noise disturbance. We looked at the significance of the coefficients and also AIC or BIC in the final model selection.[17]

The prevalence of drink driving and speeding was further disaggregated by time of the day, day of the week, type of vehicle and posted speed limit. Epi Info 6 was used for data entry and all statistical analyses were conducted in Stata 13.

An Institutional Review Board (IRB) approval was obtained from Johns Hopkins Bloomberg School of Public Health and China CDC.

Results

The 15 rounds of observational studies on speeding covered 151,440 and 117,494 drivers in Dalian and Suzhou, respectively; the drink driving data covered 39,590 and 28,057 drivers, respectively.

Fig. 1 illustrates the percentage of vehicles driving above the speed limit from the 15 rounds of observational studies. The prevalence of speeding was 31.8% (95% CI: 29.2–34.5) in the first observational study conducted in May 2011 in Dalian and gradually declined, and a substantial reduction was observed in the seventh round (July 2012), which showed the prevalence at 9.3% (95% CI: 8.7–10.0). This low level was sustained until the end of the project; 7.4% (95% CI: 7.0–7.9) in the last round (November 2014). The overall change in the prevalence of speeding between March 2011 and November 2014 was statistically significant at 24.4% (P-value 0.001).

In Suzhou, the reduction was also statistically significant (Fig. 1). In the first round of observational studies (March 2011), the speeding rate was 13.5% (95% CI: 11.7–15.5), and then the rate fluctuated. It reduced to 8.3% (95% CI: 7.8–8.9) in round 10 (October 2013), and remained at a low level. The overall reduction of 6.6% (P-value 0.001) is statistically significant.

As shown in Table 1, the statistical significance of the overall declining trend was confirmed in the time series model. A first-order autoregressive process without a moving-average structure in the disturbance term has low AIC and BIC in Suzhou and therefore are chosen as the final model. In Dalian, adding a moving-average structure to the disturbance term lowered AIC and BIC.

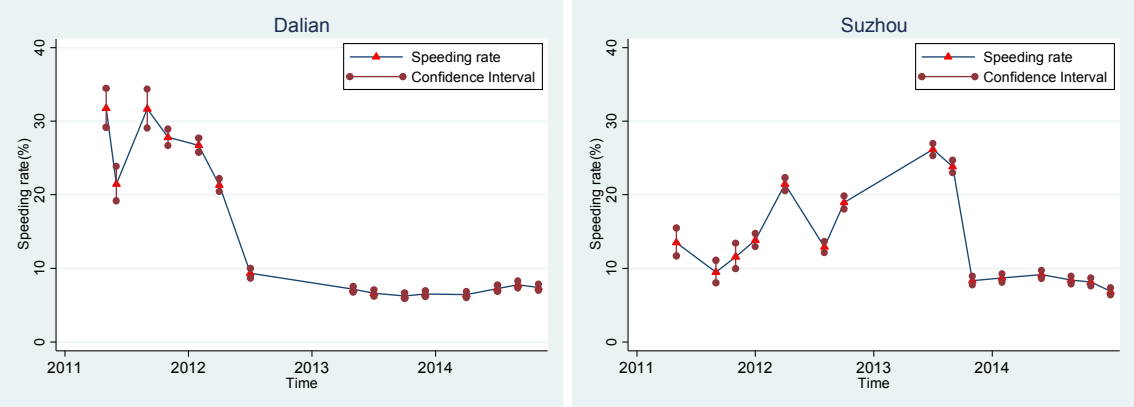

Fig. 1 – Trends in the prevalence of vehicles driving above posted speed limit in Dalian and Suzhou from 2011 to 2014.

The estimate of parameter ρ (L1.ar in the model, denoting the first-order autoregressive coefficient) is below one in both cities, indicating a declining trend. The estimate is highly statistically significant in Dalian, but only marginally significant in Suzhou, probably because the latter started with a lower speeding rate with limited room for further reduction.

Disaggregated by day of the week, the speeding rate was higher on weekdays than weekends in both cities (Fig. 2). In Dalian, Friday had the highest prevalence of vehicles driving above the speed limit (17.3%), which is more than two times higher than the prevalence on Saturday (7.0%) and Sunday (6.5%). The overall speeding rate on weekdays is nearly twice of the rate on weekends (11.4% vs 6.8%). Suzhou had similar pattern, but the difference between weekdays and weekends was smaller (14.0% vs 12.2%). As illustrated in Fig. 3, the speeding rate peaked in the morning rush hours in Suzhou, but in Dalian the middle of the day and later afternoon saw an elevated speeding rate.

The speeding rate varied greatly across types of vehicles (Fig. 4). SUVs and saloon cars were more likely to exceed the posted speed limit than other types of vehicles in both cities. Light and large trucks and buses had the lowest speeding rate in Dalian while the lowest rate was observed for large truck and buses in Suzhou.

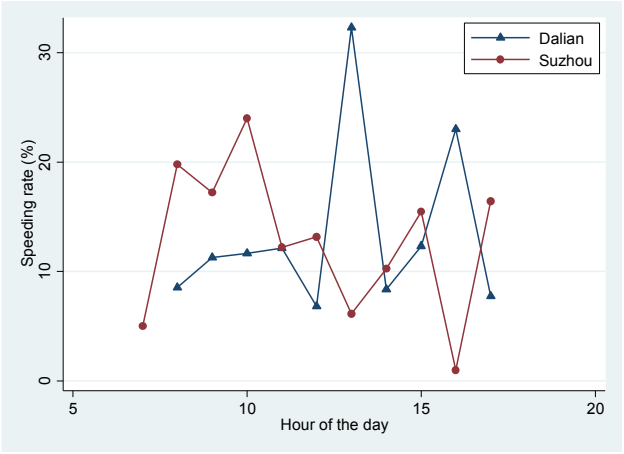

Fig. 3 – Prevalence of vehicles driving above posted speed limit in Dalian and Suzhou by hour of the day.

Table 1 – Time series models for drink driving and speeding in Suzhou and Dalian.

Result	Suzhou		Dalian	
	Drink driving	Speeding	Drink driving	Speeding
L1.ar	0.61***	0.56	0.91***	0.90***
L1.ma	N/A	N/A	−0.52	−0.12
Intercept	1.97	13.38	1.02*	16.99
No. of observations	15	15	15	15

*P < 0.05; **P < 0.01; ***P < 0.001; the P-value for speeding in Suzhou is 0.06.

The proportion of speeding was also associated with the posted speed limit. Fig. 5 shows that more than 60% of vehicles were speeding in Dalian sites where the posted speed limit was 50 km/h. The proportion reduces to 3.1% where the speed limit was 80 km/h and further to 2.5% for a speed limit 90 km/h.

The difference in the timing of reduction in speeding rate is consistent with the work plan in the two cities. Starting with a high speeding rate, Dalian prioritized interventions on reducing speed during the first two years of the project. Suzhou started with a high drink driving rate and initially prioritized this risk factor. During the last two years, interventions on both risk factors were implemented in both cities.

In Dalian, the project began with a very low prevalence of drink driving at 1.7% (95% CI: 1.1–2.4) during the first round of observational studies (January 2011). Fig. 6

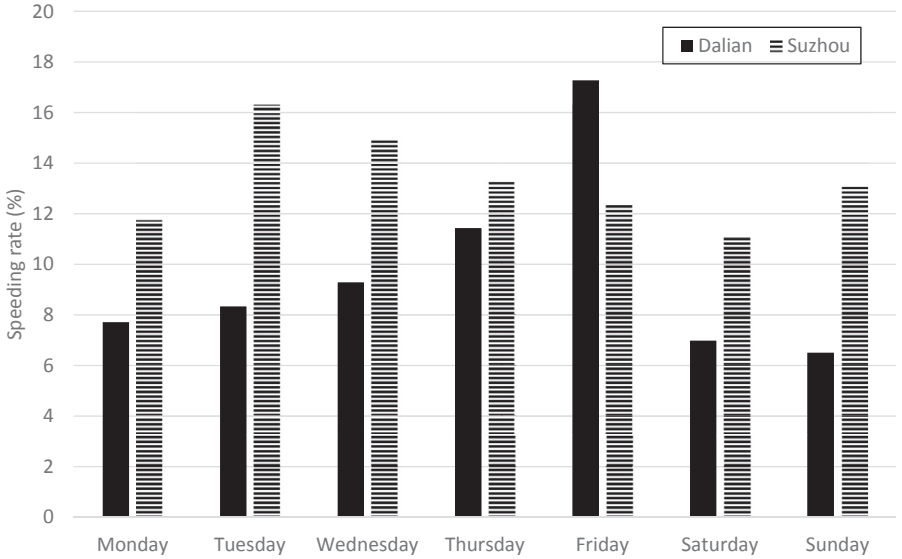

Fig. 2 – Prevalence of vehicles driving above posted speed limit in Dalian and Suzhou by day of the week.

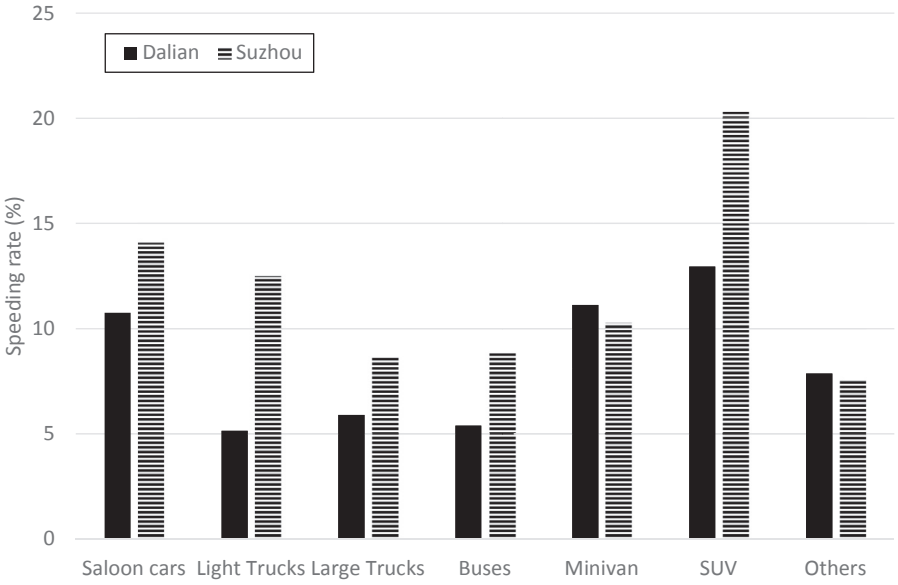

Fig. 4 – Prevalence of vehicles driving above posted speed limit in Dalian and Suzhou by type of vehicle.

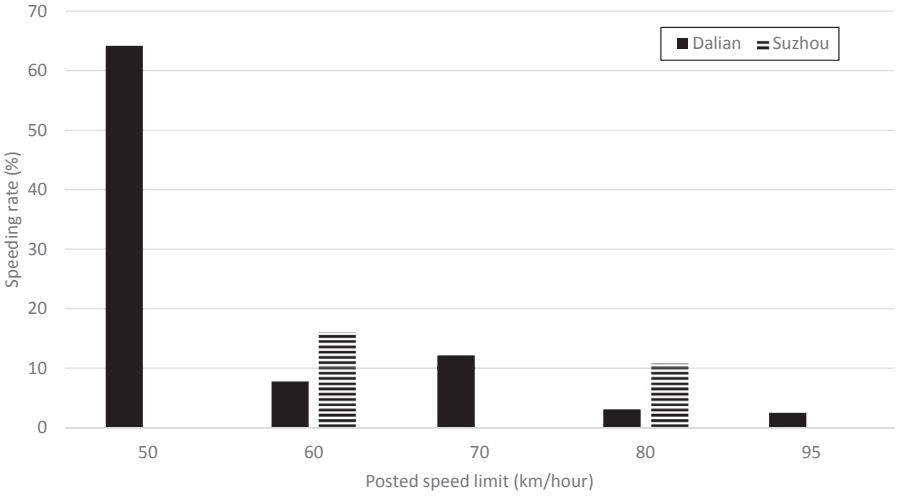

Fig. 5 – Prevalence of vehicles driving above posted speed limit in Dalian and Suzhou by posted speed limit.

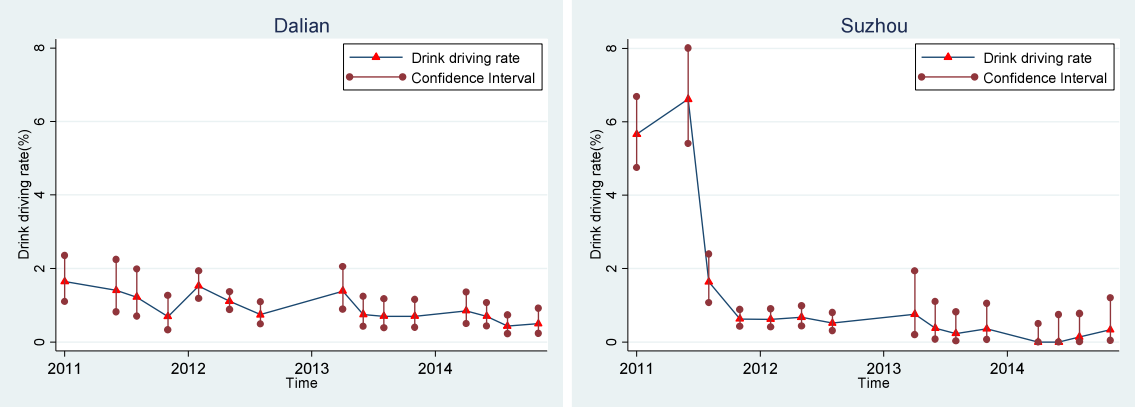

Fig. 6 – Trends in the prevalence of drink driving in Dalian and Suzhou from 2011 to 2014.

illustrates the fluctuating drink driving rates observed in subsequent data collections. In the last round (November 2014), the drink driving rate was 0.5% (95% CI: 0.2–0.9), and the overall change was 1.2%, which was statistically significant (P-value < 0.05).

Suzhou started with a higher drink driving rate at 6.4% (95% CI: 5.4–7.4) in January 2011, and then declined dramatically (Fig. 6). During the project period, we observed a reduction of 5.9% point, which was statistically significant (P-value < 0.001).

The statistical significance of reduction is confirmed in time series models. As illustrated by Table 1, the coefficient of interest ρ is highly significant in both cities.

No variations in drink driving rate between weekdays and weekends were observed in these two cities (Fig. 7). In Dalian, the rate appeared to be lower on Friday and Sunday and higher on Monday and Tuesday; the highest rate occurred on Wednesday and lowest on Friday. But the difference was small.

A particularly successful case was observed on Donglian road in Dalian, which warrants further explanation. Donglian is an urban, limited-access, elevated highway zone. It is 11.3 km long, has three lanes for each direction, has a speed limit of 60 km/h and primarily carries car traffic. An interval-based speed enforcement system was installed and tested at Donglian road from January 2012 to April 2012 and used for speed enforcement starting in May 2012. The system used 19 high-resolution cameras on exit/entry ramps to record licence plate numbers. Speed limit violations were determined by comparing the duration that vehicles spend within the enforcement zone with the time required for a vehicle travelling at the speed limit. The effect of the enforcement caused the percentage of vehicles travelling at speeds >10% on Donglian road to decline from 0.50 to 0.03, while proportions remained stable at other sites and did not show any secular trends. The proportions of vehicles travelling >20% and >30% above the speed limit on Donglian road and the other sites varied similarly. These results suggest that interval-based speed enforcement systems can be effective in zone-wide speed reductions in China.

Discussion

Our observational studies suggested that the prevalence of drink driving in both cities showed statistically significant declines from baseline measurements. This trend is encouraging as the reductions occurred during a period of intense activities by the Global Road Safety Programme and also by the local and national agencies focussing on enforcement and behaviour modification campaigns.

It should be noted that the baseline prevalence measurement was already low, especially in Dalian, where the drink driving rate was only 1.6%. It is consistent with a previous study that worked with police to measure drink driving in Guangxi province in 2006–2007 that also reported low prevalence of drink driving compared with other countries.[14] However, in other settings, such as the US, the prevalence of drink driving is more than 10 times higher.[18–20]

Our speed measurements in Suzhou showed that the overall prevalence of speeding in the city is relatively low, which may be attributed to the existence of a vast network of automated speed enforcement cameras across the city. In contrast to Suzhou, the prevalence of speeding was much higher at baseline in Dalian, which does not have an extensive network of speed enforcement cameras.

A recent review of the literature found that in recent years interval-based speed enforcement systems have become popular throughout Europe and Australia and that a growing body of evidence suggests high rates of compliance with speed limits, reductions in average and 85th percentile speeds, reduced traffic speed variability and reductions in fatal and serious injury crashes.[21] Further research is needed to understand the political barriers to the widespread deployment of such systems worldwide.

Although our overall findings for speeding and drink driving in Suzhou and Dalian indicate improvements, the results should be interpreted with caution. While it is possible that the interventions focussed on drink driving in Suzhou and Dalian are an explanation for the measured decline in percentage of drink driving, we need to understand the

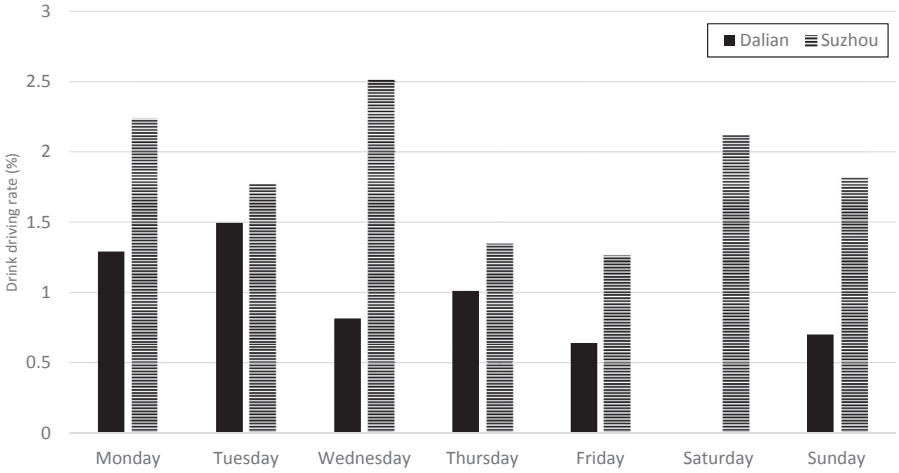

Fig. 7 – Prevalence of drink driving in Dalian and Suzhou from by day of the week.

limitations in our measurement. Our observational data on both risk factors were collected with heavy involvement from the police. Conducting the speed observations inside police vehicles in Dalian may have led to underestimation.[22] Observation sites for drink driving were chosen by the police where drink driving is most likely to occur. So the observed prevalence may be higher than the prevalence in the population.[20] Despite the limitations, data collection procedures were kept nearly identical across rounds to ensure the comparability of the results. Consequently, our conclusion on the trends is less affected by the limitations than it appears.

Fully aware of those potential drawbacks, we decided to collaborate with police instead of an outside group using covert methods because of the importance of promoting police engagement and local ownership. Involvement in design and implementation of data collection may enhance the credibility of data with police that manage road safety in China.

Attribution of the changes is a challenge in an observational study.[23,24] During the project period 2010–2014, the two intervention cities had substantially developed their road safety infrastructure. Many changes were made to legislation and law enforcement, some of which were initiated at the national level while others at the local level. To compound the issue, there is limited information on the changes of socioeconomic variables, such as road construction. All of these factors make it difficult to accurately attribute the observed changes to the Global Road Safety Programme. There are no national statistics on the prevalence of drink driving and speeding in China, but a few studies were conducted in other Chinese cities during the project period 2010–2014.[14] A study in five randomly selected cities in Shandong provinces recorded a decrease in the prevalence of drink driving from 2011 to 2013, while the change is less substantial than the observed in Suzhou and Dalian.[25] Although China has been developing rapidly overall during the project period, the growth rate of population and registered motorized vehicles was higher than most regions in China, which made preventing speeding and drink driving more challenging.[15,26] In summary, despite the attribution challenge, our results suggest that with coordinated efforts, drink driving and speeding can be controlled in China. The expansion of such activities to other cities will likely yield comparable improvements in road traffic safety.

Given the achievements of the Global Road Safety Programme China interventions, it is desirable to share good practices with other cities and regions in China. Given the seriousness of RTIs in China, it is expected that more local governments will prioritize road safety and show an interest in learning from the programme's intervention models. Some of the project interventions require well-developed traffic and media infrastructure. With this in mind, the programme's lessons may be useful for other big cities, such as Beijing and Shanghai, to improve road traffic safety. Appropriate revisions and adaptations are needed to develop strategies applicable to small cities and rural areas with limited financial support from local governments and less developed road safety infrastructure.

The achievements of the Global Road Safety Programme China interventions largely come from the legislative changes, training and capacity-building provided by the international collaborators and the intensified network between local health and police departments. This is consistent with previous findings.[27–29] As a result, the reduction in speeding and drink driving achieved during the past five years is expected to sustain even after the project ends. The changes in people's knowledge, attitude and practice will continue to affect road traffic safety outcomes in the near future. The legacy of the project includes efforts to build the capacity of national and local project team members and the intensified collaborations between international and Chinese researchers and between local health and police departments.

Author statements

Acknowledgements

The authors are grateful to researchers from the Suzhou Center for Disease Control and Prevention and the Dailan Center for Disease Control and Prevention who implemented the primary data collection activities. The authors are also grateful to the World Health Organization and the Global Road Safety Partnership for their support, cooperation and guidance.

Ethical approval

None sought.

Funding

This work was conducted as part of the Global Road Safety Programme, funded by Bloomberg Philanthropies. Publication of this paper was supported by Bloomberg Philanthropies through a grant to the Johns Hopkins International Injury Research Unit at the Johns Hopkins Bloomberg School of Public Health, USA.

Competing interests

None declared.

REFERENCES

1. WHO. *Global status report on road safety*. 2015.
2. Zhou M, Wang H, Zhu J, Chen W, Wang L, Liu S, et al. Cause-specific mortality for 240 causes in China during 1990–2013;2013: a systematic subnational analysis for the Global Burden of Disease Study 2013. *Lancet* 2016;**387**(10015):251–72.
3. Chen H, Du W, Li N, Chen G, Zheng X. The socioeconomic inequality in traffic-related disability among Chinese adults: the application of concentration index. *Accid Anal Prev* 2013;**55**:101–6.
4. Lin T, Li N, Du W, Song X, Zheng X. Road traffic disability in China: prevalence and socio-demographic disparities. *J Public Health (Oxford, England)* 2013;**35**(4):541–7.
5. Li Q, He H, Liang H, Bishai DM, Hyder AA. One outcome, many trends: understanding national data sources for road traffic fatalities in China. *Am J Public Health* 2016;**106**(10):1793–5.

6. Zhang G, Yau KK, Gong X. Traffic violations in Guangdong Province of China: speeding and drunk driving. *Accid Anal Prev* 2014;**64**:30–40.
7. MPS. *Annual bulletin of road traffic crashes of China*. Wuxi. 2014.
8. Rao Y, Zhao Z, Zhang Y, Ye Y, Zhang R, Liang C, et al. Prevalence of blood alcohol in fatal traffic crashes in Shanghai. *Forensic Sci Int* 2013;**224**(1–3):117–22.
9. Jia K, Fleiter J, King M, Sheehan M, Ma W, Lei J, et al. Alcohol-related driving in China: countermeasure implications of research conducted in two cities. *Accid Anal Prev* 2016;**95**(Pt B):343–9.
10. Jia K, King M, Fleiter J, Sheehan M, Ma W, Lei J, et al. General motor vehicle drivers' knowledge and practices regarding drink driving in Yinchuan and Guangzhou, China. *Traffic Inj Prev* 2015;**16**(7):652–7.
11. Hyder AA, Allen KA, Di Pietro G, Adriazola CA, Sobel R, Larson K, et al. Addressing the implementation gap in Global Road Safety: exploring features of an effective response and introducing a 10-country program. *Am J Public Health* 2012;**102**(6):1061–7.
12. Peden M. Road safety in 10 countries. *Inj Prev* 2010;**16**(6):433.
13. Larson K, Henning K. Implementing proven road safety interventions saves lives. *Injury* 2013;**44**(Suppl. 4):S3.
14. Li Y, Xie D, Nie G, Zhang J. The drink driving situation in China. *Traffic Inj Prev* 2012;**13**(2):101–8.
15. Bureau DS. *Dalian statistical report for economic and social development* (accessed 15 September 2015). 2014.
16. Acock AC. *A gentle introduction to Stata*. Stata press; 2008.
17. Hurvich CM, Tsai C-L. Regression and time series model selection in small samples. *Biometrika* 1989;**76**(2):297–307.
18. Hingson R, Winter M. Epidemiology and consequences of drinking and driving. *Alcohol Res Health* 2003;**27**(1):63–78.
19. Vanlaar W. Drink driving in Belgium: results from the third and improved roadside survey. *Accid Anal Prev* 2005;**37**(3):391–7.
20. Sousa T, Lunnen JC, Gonçalves V, Schmitz A, Pasa G, Bastos T, et al. Challenges associated with drunk driving measurement: combining police and self-reported data to estimate an accurate prevalence in Brazil. *Injury* 2013;**44**(Suppl. 4):S11–6.
21. Soole DW, Watson BC, Fleiter JJ. Effects of average speed enforcement on speed compliance and crashes: a review of the literature. *Accid Anal Prev* 2013;**54**:46–56.
22. Bhalla K, Li Q, Duan L, Wang Y, Bishai D, Hyder AA. The prevalence of speeding and drunk driving in two cities in China: a mid project evaluation of ongoing road safety interventions. *Injury* 2013;**44**(Suppl. 4):S49–56.
23. Heckman JJ, Robb R. Alternative methods for evaluating the impact of interventions. *J Econ* 1985;**30**(1):239–67.
24. Campbell NC, Murray E, Darbyshire J, Emery J, Farmer A, Griffiths F, et al. Framework for design and evaluation of complex interventions to improve health. *BMJ* 2000;**321**(7262):694–6.
25. Wang Z, Zhang Y, Zhou P, Shi J, Wang Y, Liu R, et al. The underestimated drink driving situation and the effects of zero tolerance laws in China. *Traffic Inj Prev* 2015;**16**(5):429–34.
26. China NBoso. *Yearbook, China statistical. China statistical yearbook*. 2014.
27. Varvasovszky Z, McKee M. An analysis of alcohol policy in Hungary. Who is in charge? *Addict (Abingdon, England)* 1998;**93**(12):1815–27.
28. World Health Organization. *Global status report on road safety: time for action*. Geneva: World Health Organization; 2009.
29. Suriyawongpaisal P, Kanchanasut S. Road traffic injuries in Thailand: trends, selected underlying determinants and status of intervention. *Inj Control Saf Promot* 2003;**10**(1–2):95–104.