Since the outbreak of the novel coronavirus, defensive measures such as handwashing and social distancing, derived from epidemiological research into the spread of viruses, have begun to play a fundamental part in our everyday lives. However, in China, epidemiologists have been working for decades to tackle another widespread public health problem: road traffic accidents—similarly viewing them as a noncommunicable “disease” that claims the lives of tens of thousands of citizens each year.

In 2018, 63,194 traffic accident fatalities were recorded by the country’s National Bureau of Statistics (1). Since 1990, China has ranked first in the world for traffic fatalities (2), explains Wannian Liang, an epidemiologist at the country’s National Health Commission, who is also leading China’s efforts to fight the spread of COVID-19.

“The increase in traffic accidents has brought huge disasters to countless families,” says Liang.

Since China’s reform and opening period at the end of the 1970s, when the country shifted away from a planned economy toward a market-based model with Chinese characteristics, it has experienced rapid growth. China is now the world’s largest auto market. In 2018, it produced approximately 23.5 million passenger cars and claimed a 27.6% share of total global vehicle production (3).

However, such explosive growth resulted in a dramatic rise in traffic accidents. In the 1980s, Chinese epidemiologist Huiqing Jin took the lead in conducting epidemiological studies on car accidents (4). Shenyong Wang of Jinan University and other researchers at multiple institutions soon followed him, carrying out several relevant studies in a cross-disciplinary effort to better understand how, why, and when these accidents occurred—and how government policy could help ensure better health outcomes for drivers and passengers. Their work led to the adoption of China’s first road traffic safety law in 2003.

According to Jihong Zhou, director of China’s Institute for Traffic Medicine, this law, among several others, helped curb the rapid increase of traffic accidents and fatalities in China. The number of serious traffic accidents (i.e., resulting in death or disability) dropped from 49 per year on average before 2008 to 2 in 2019, a drop of more than 90%, says Liang.

Kumares Sinha, professor of civil engineering at Purdue University in Lafayette, Indiana, thinks China’s approach to prevention and control of major traffic crashes is similar to its prevention and control of the COVID-19 virus. “The country has employed a public-health based program involving a series of measures including driver screening, along with enforcement of vehicle inspection and traffic laws, and improved roadway features and surveillance,” says Sinha. “This concerted effort has achieved remarkable results, and may be useful for other countries to learn and adopt.”

A fast-moving nation

The causes of traffic accidents in China have changed over time in line with the country’s economic growth. In the 1980s, most were related to push bikes and pedestrians, says Zhou. As new modes of transportation were introduced, they were accompanied by a high casualty rate, he explains. In the 1990s, there was a rise in motorbike accidents in the southern city of Guangzhou, where many of China’s economic changes were being rolled out in pilot form. By the start of the following decade, as China’s road system was developed, 45% of those who died in highway accidents in China were pedestrians, unused to the new infrastructure. In 2020, China faces the challenges posed by the uptick in the use of domestically manufactured electric bikes (e-bikes), which have risen in production from 56,000 in 1998 to 32 million in 2018 (5, 6). Between 2013 and 2017, more than 56,000 traffic accidents were caused by e-bikes, resulting in over 8,000 fatalities and 63,000 injuries (7).

Challenge for epidemiologists

China faces a unique set of challenges when it comes to road safety. Changjun Wang, director of the Traffic Management Research Institute of China’s Ministry of Public Security, says that the country entered...
the era of modern motorization later than other countries, so citizens have had less time to develop an awareness of safe driving behaviors and the need to follow traffic rules. There are also issues to address in terms of the safety of the roads and of motor vehicles themselves. However, Greg Smith, managing director of strategic projects for the International Road Assessment Programme (IRAP), an organization that has worked closely with China’s transport experts for the past decade, says there are a number of positive factors that set the country’s approach to safety apart from other developing countries.

“The research capability in China is relatively high. The Research Institute of Highway, the sole national-level research institute in the transportation area, for example, has more than 2,000 staff, many of whom have Ph.D.-level qualifications,” notes Smith.

He adds that the government’s State Council, the country’s executive governing committee, has also strongly supported improvements to road safety.

“They have a program called ’The Highway Safety to Cherish Life Project,’ with billions of dollars having already been invested,” Smith says. “The program has involved rapidly adapting local and international research about the link between road design and crash risk into ChinaRAP [China Road Assessment Programme] road inspections assessments to identify locations where improvements will generate the best savings and to retrofit highways with safety facilities, like safety barriers.”

### How epidemiology has underpinned change

From the early-1990s, the work of Huiquing Jin, who founded the Sanlian Accident Prevention Institute in Anhui Province, has been used to come up with solutions to change the habits of accident-prone drivers. Jin treated traffic accidents as though they were a disease that could be cured. His team proposed a theory called “Three Lines of Defense,” based on their understanding of the physiological and psychological behavioral characteristics that prompted drivers to make errors that caused accidents.

Jin’s system proposed three stages for implementing the country’s road safety system. First, officials would identify accident-prone drivers via visual acuity and mental alertness tests. Second, poor drivers would receive training to improve their performance. Third, local governments would install cameras at hotspots for traffic accidents that could, for example, help police watch for abnormal driving behavior, enforce traffic violations, and mount a quick emergency response after an accident.

A pilot system was rolled out in 2006 in Jinan, the capital of eastern China’s Shandong Province, as part of the United Nations Global Compact Cities Programme. “It has proven to be effective in restraining high-risk groups and preventing accidents from occurring in the first place,” says Zhou.

Similarly, Tanigawa Takeshi from Juntendo University, in Tokyo, Japan, has focused on the epidemiological study of obstructive sleep apnea as an important cause of traffic accidents for the past 15 years. He says that while other early industrialized countries have invested significant resources in vehicle and road improvements, they have paid less attention to drivers. For example, in Japan, similar tests to identify accident-prone drivers are not based on epidemiological data.

“Jin’s team has created a database of bad driving behaviors, classified these behaviors, and constructed a model for the accidents induced by them. From this, you can obtain key parameters of the disease and develop the most effective measures for its control,” says Takeshi.

### Epidemiology in action

A key component of Jin’s theory lies in its implicit understanding that detailed knowledge about people’s behaviors is key to creating policies that will curb the spread of this accident epidemic. To gain this information, Chinese institutes have developed a highly integrated approach to information gathering. In China, a new interdiscipline, road traffic accident prevention and control engineering, has been established, which has promoted Chinese science and technology departments, public security teams, transportation departments, and health groups to work closely with colleges and universities, research institutes, and social organizations.

Among these academic institutions are the National Engineering Research Center for Vehicle Driving Safety, cofounded by Anhui Sanlian University and Anhui Sanlian Transportation Application Technology Company, both located in Hefei, China; the National Research Center for Traffic Management Engineering Technology, based at the Traffic Management Research Institute; and the National Intelligent Transport Systems Center of Engineering and Technology, which is supported by the Research Institute.

Sanlian Accident Prevention Institute has devised a plan to change the habits of accident-prone drivers. See text for more details. AP, accident-prone.
of Highway, Ministry of Transport. The three national centers have worked together in a concerted effort to develop key technologies and systems for improving driver safety, such as traffic status monitoring and early warning, highway risk perception and safety protection, and road network dynamic law enforcement and control. They jointly established a prevention and control system for major traffic accidents, making a significant contribution to the dramatic decline in the number of major traffic accidents in China.

Kelly Larson, program director for Bloomberg Philanthropies, agrees that China’s wide network of teams that collect and analyze data on road traffic accidents, fatalities, and injuries, is helpful. “Compared to some other countries with fewer resources [in terms of] both monetary and trained professionals, China has an advantage in their capacity to conduct research,” she says.

Implementation of epidemiological approaches

After China’s first traffic safety law was enacted in May 2004, it became a criminal offense to drive recklessly, and in 2011, driving while under the influence of alcohol became a criminal offense as well. Drivers are also now obliged to pass national examinations to ensure they have the basic knowledge, skills, and awareness it takes to be safe on the road—an important requirement, considering that there are 20 million potential new drivers each year in China.

In addition, in 2017 lawmakers revised a national safety technical standard for motor vehicles, to make certain that the 400 million motor vehicles on China’s roads would be safe to operate (8).

There have also been smaller, local initiatives based on epidemiological studies, which aim to lower the rates of accidents. For example, in Chongqing, a city in the mountainous region of central China, most traffic accidents resulting in more than three deaths have been related to cars falling off cliffs. In 2003, Zhou and his team, who had been working on the epidemiology of injuries, proposed a road safety project.

“We proposed that crash barriers should be installed on all the roads where the level difference between the road surface and the foot of a cliff is over three meters,” says Zhou.

After the project’s implementation, the city’s rate of serious accidents dropped dramatically, and the pilot project helped spur the development of a nationwide road safety initiative organized by China’s central government.

Smith says there is often a kind of inertia among road engineers and designers when it comes to designing transport infrastructure, not just in China but in many countries.

“Road projects tend to have tight deadlines, limited budgets, and a heavy focus on compliance with often strict design standards that don’t always properly reflect the true nature of the road environment,” he says. “That means that safety often gets marginalized in an effort to just get the roads built, and that introducing new concepts and approaches is a challenge. Creating more special demonstration projects, to give designers and engineers the authority to [develop] trial approaches, would help.”

How can further improvements be made?

According to Wang, it is time for China to consolidate its research into a "National Road Traffic Safety Strategic Plan" that will clarify the objectives of road traffic safety management. Four crucial elements of the plan that he wants to see developed include strengthening research on the basic theory and key technologies of traffic safety, broadening public awareness and education about traffic safety, improving laws relating to all aspects of transportation safety, and increasing investment in traffic safety technology.

The growth in the use of e-bikes in China is an area of particular concern to experts across the world. “E-bikes are involved in many crashes and account for a significant number of road traffic fatalities,” says Larson. “We encourage the governing authorities to consider strong regulations on mandatory helmet wearing for e-bike riders.”

A Chinese government road safety campaign launched in May of this year has encouraged widespread use of helmets, but their use is not yet a national regulation.

But Smith notes that despite the high use of e-bikes, the estimated death rate for riders in China’s most populous city, Shanghai, was about 2 per 100,000 population in 2016 (9), which is relatively low—about the same as the combined bicycle and motorcycle death rate in the Netherlands.

The future of traffic safety

Jin recently urged that, in the future, the passive preventive measures that the government administration forces traffic participants to carry out should be transformed into active preventive habits that meet the voluntary implementation of traffic participants. Let the driver constantly improve their safety behavior and self-safety awareness (10), he adds.

Liang agrees that the main factors preventing traffic accidents are safety awareness and the cultivation of safe behaviors. He believes that just as epidemiologists try to control infectious diseases, those researching the epidemiology of traffic accidents should conduct cohort studies on how these preventive measures affect outcomes and on the factors that must always be in place to ensure drivers act safely.

References