Automobiles and Safety

1 Introduction

According to traffic accident statistics compiled by the National Police Agency of Japan, the number of traffic accidents fell for the ninth consecutive year in 2013 (Fig. 1). However, despite this downward trend, the number of accidents still remains at a high level. Furthermore, although the number of traffic accident fatalities (i.e., the number of fatalities that occurred within 24 hours of the accident) has fallen for thirteen consecutive years from 2000, the rate of decrease is showing signs of bottoming out. In fact, the number of elderly people (aged 65 or older) killed in traffic accidents in 2013 rose for the first time in twelve years and now accounts for more than half of all traffic accident fatalities. This proportion is higher than that in either Europe or the U.S. and underlines the urgent need for Japan to implement further measures to help reduce the number of traffic accident fatalities among the elderly. In March 2011, the Japanese Government issued its 9th Fundamental Traffic Safety Program, which extends to 2015. For road traffic, the government is targeting the achievement of the world's safest road traffic environment, specifically (1) 3,000 or fewer traffic accident fatalities and (2) 700,000 or fewer traffic accident injuries and fatalities. Achieving these targets will require even greater efforts to develop more advanced safety technology.

2 Traffic Accident Trends and Measures

2. 1. Traffic accident trends

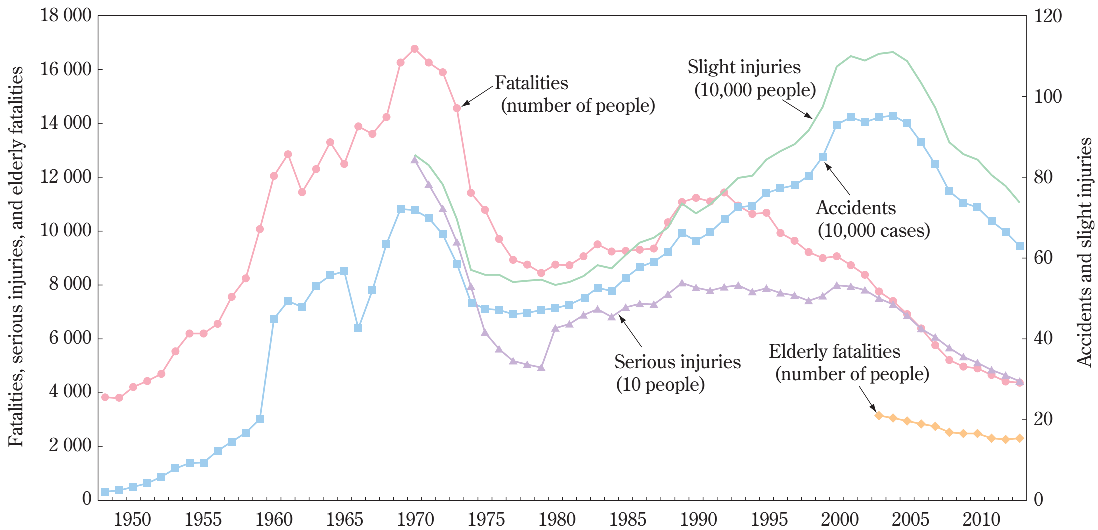
The following sections outline the salient characteristics of fatal accidents in 2013.

2. 1. 1. Number of fatalities per road user status

Of the 4,373 traffic accident fatalities in 2013, pedestrians accounted for the largest proportion (1,584 people, 36.2% of the total). However, this number was 3.1% less than in 2012. The next highest total was vehicle occupants (1,415 people, 32.2% of the total, and 0.1% less than 2012), followed by motorcycle (motor driven and electric) riders (760 people, 17.4% of the total, and 3.6% less than 2012), and cyclists (600 people, 13.7% of the total, and 6.6% more than 2013). Pedestrians have accounted for the largest proportion of traffic accident fatalities for six consecutive years. Furthermore, the size of this proportion has remained virtually unchanged for a decade (Fig. 2).

2. 1. 2. Number of elderly fatalities

In 2013, the number of fatalities aged 65 or older was 2,303 people, 52.7% of the total (Fig. 3). Furthermore, elderly people accounted for 70.5% of pedestrian fatalities and 63.0% of cyclist fatalities, which suggests that elderly people make up a high proportion of traffic accident victims (Fig. 4). However, statistics for the number of fatal accidents per 100,000 driving license holders determined to be the first party in an accident also show that elderly drivers (6.4 fatalities per 100,000) had the second highest number of fatalities after drivers aged 16 to 24 (8.3 per 100,000) (Fig. 5). The category of the traffic law violated by elderly drivers in traffic accidents was also analyzed. Failure to confirm safety was the most common category (34.8%). This figure was higher than the overall figure of 30.6%. The proportions of elderly drivers who carried out an inappropriate driving maneuver, failed to stop at a stop sign, or ignored a traffic signal were also higher than the overall figures for all age groups (Fig. 6). These figures underline the importance of helping to prevent accidents caused by elderly drivers. It may be possible to achieve this through measures or systems to compensate for the effects of aging, such as slower judgment, mistaken driving operations, and failure to recognize traffic signs. The 9th Fundamental Traffic Safety Program focuses on road traffic safety measures from three standpoints: ensuring the safety of elderly people and children, ensuring the safety of pedestrians and cyclists, and ensuring safety on residential and arterial roads. Recent fatality trends for road user status and age have taken on seemingly fixed patterns and further measures



Notes:
(1) Until 1959, these statistics did not include the number of slight injuries (injuries recognized within 8 days from the accident and causing damage property valued at 20,000 yen or less).
(2) Until 1965, these statistics also included accidents involving damage to property only.
(3) Until 1971, these statistics did not include Okinawa Prefecture.

Fig. 1 Traffic accident trends.

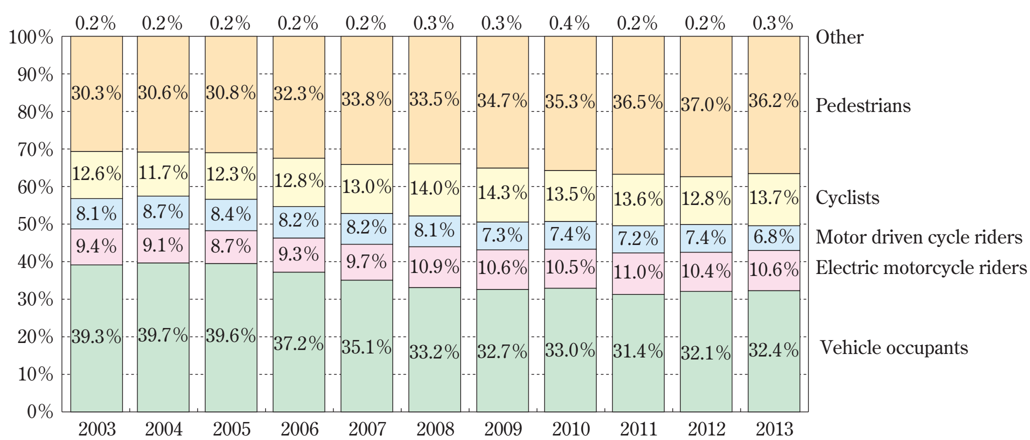


Fig. 2 Fatality trends per road user status.

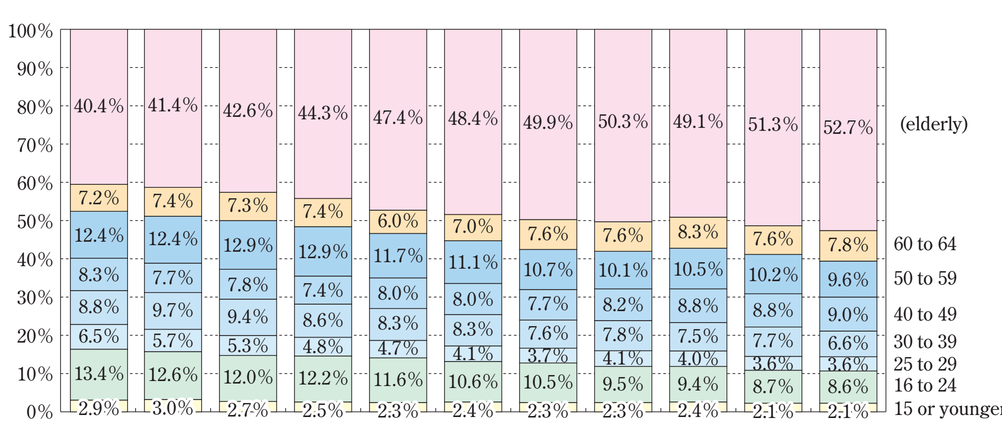


Fig. 3 Fatality trends per age range.

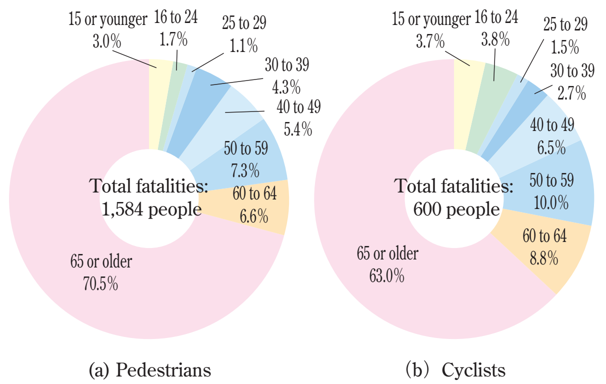


Fig. 4 Proportion of elderly pedestrian and cyclist fatalities.

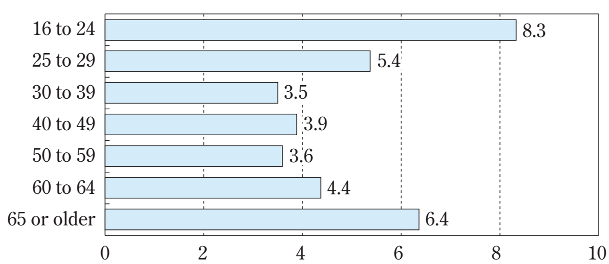


Fig. 5 Number of fatal accidents per 100,000 driving license holders (motor-driven cycle or larger) defined as accident first party per age group (2013).

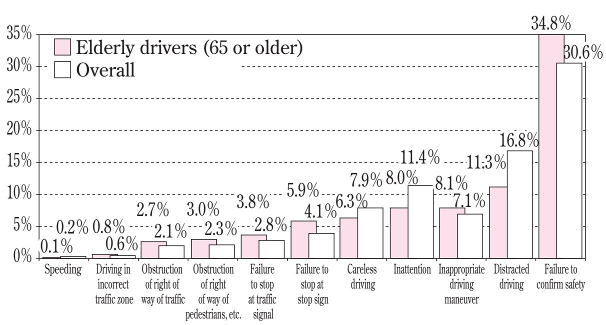


Fig. 6 Category of traffic law violated in traffic accidents by driver of motor-driven cycle or larger (2013).

to ensure the safety of elderly pedestrians are considered to be of particular importance. In addition, as the aging of society gathers pace, there is increasing social concern about accidents caused by sudden-onset medical problems. For this reason, establishing new survey methods and identifying the actual situation surrounding this issue is an urgent task for the future.

2. 2. Traffic accident measures

Based on the 9th Fundamental Traffic Safety Program, the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT) formulated the 2013 MLIT Traffic Safety Work Plan. This plan includes the following points relevant to vehicles.

-Promotion of improvements to standards and the like related to vehicle safety

-Promotion of development and popularization of advanced safety vehicle (ASV) technology

-Provision of vehicle assessment information

-Enhancement of vehicle insurance and inspection

-Enhancement and reinforcement of the recall system

The following sections discuss the areas of safety standards, ASV technology, and vehicle assessment.

2. 2. 1. Enhancement and reinforcement of safety standards

MLIT's traffic safety measures are based on a report called Vehicle Safety Measures for Building a Society Free from Road Traffic Accidents, which was drawn up in June 2011 by the Vehicle Traffic Subcommittee of the Land Traffic Committee under the Council for Transport Policy. This report describes measures for responding to the declining birth rate and aging population, helping to prevent accidents involving pedestrians and cyclists, helping to alleviate accident injuries, new means of mobility, and helping to reduce serious accidents involving heavy-duty vehicles. Current standardization items include the following.

-Measures related to the quietness of hybrid and other vehicles

-Actions to formulate globally unified standards for lithium-ion batteries

-Active safety measures to help prevent rear-end collisions involving heavy-duty vehicles and the like

-Safety standards for pedestrian protection and head restraints

2. 2. 2. Promotion of development and popularization of ASV technology

The development and popularization of ASV technology is being encouraged through the ASV Promotion Project under the auspices of MLIT. A series of five-year project phases started in 1991. The fifth project phase began in 2011 with the aim of achieving a safe and secure traffic environment based on harmony between people and vehicles. It consists of study items related to the following three topics.

-The growing sophistication of ASV technology

-The promotion of technology for communication-based safety support systems

-The awareness and popularization of ASV technology

One aim of the studies related to the growing sophistication of ASV technology is to revise the concept of driver support drawn up in the third phase of the project.

Another aim is to formulate basic performance guidelines for systems addressing abnormal driver states, which began in the fourth phase of the project. This topic also covers the identification and confirmation of technical issues of multiple driver support systems and the operation of these systems, in addition to the definition of concepts for over-confidence and dependence related to the expansion of safety support functions. The studies related to the promotion of technology for communication-based safety support systems involve work to revise the guidelines for communication-based safety support systems issued in phase four of the project. This revision work includes the further development of current safety applications, the development of additional applications, and further considerations for practical system adoption. The feasibility of systems based on pedestrian-vehicle communication (such as the prediction of system effectiveness through pedestrian accident analysis and the issues of separate pedestrian-vehicle communication specifications) is also beign studied.

Finally, the 2013 ITS World Congress in Tokyo was used as a showcase to demonstrate various systems with the aim of increasing awareness and popularizing ASV technologies.

2. 2. 3. Vehicle safety assessments in Japan

The Japan New Car Assessment Program (JNCAP) for evaluating vehicle safety began in 1995. From 2000, JNCAP has awarded a total score to new vehicles based on the results of three tests: full-lap frontal collision, offset frontal collision, and side collision tests. Since then, various individual tests have been added, including those for pedestrian head protection performance, neck injury protection performance in a rear-end collision, rear passenger's seat belt usability, passenger seat belt reminder performance, braking performance, rear seat passenger protection performance in a frontal collision, and pedestrian leg protection performance. As a result, although JNCAP had been evaluating safety under a wider range of collision conditions, the assessment results became more complicated and difficult to understand. Therefore, since 2011 a new total score was introduced to provide an overall assessment of the test results. Since 2012, taking into account the real-world accident state, the neck injury protection rear-end collision performance test has been performed under severer conditions at higher test speed.

2. 2. 4. Trends of vehicle safety assessments outside Japan

As is the case with JNCAP, more vehicle safety assessments outside Japan are also using total scores calculated by combining the results from an increasing number of tests and factoring in the effects of advanced safety equipment. Euro NCAP already uses a total score that combines the results of frontal, side, and pedestrian impact tests, with the performance of skid-prevention devices (i.e., ESC), seat belt reminders, and auxiliary speed limiter safety systems. In the U.S., the National Highway Traffic Safety Administration (NHTSA) carries out US-NCAP. In the past, US-NCAP assessed vehicles based on full-frontal crashworthiness, side-impact protection, and rollover resistance. However, in 2010, the assessment methods for the frontal and side-impact tests were changed and an overall score was introduced that combines the results of these three evaluations. Also in the U.S., in 2012, the Insurance Institute for Highway Safety (IIHS) introduced the small overlap test that assesses a collision between the front corner of a vehicle and an object, and integrated the results into the overall safety score.

Another major trend in vehicle safety assessments is the expansion of regions adopting the NCAP system. Since the introduction of US-NCAP, similar assessments have been introduced in Japan, Europe, Australia, Korea, China, Central and South America, and Southeast Asia. India is also currently studying the introduction of NCAP.

3 Research and Technology Related to Active Safety

Since the number of people killed and injured in traffic accidents remains unacceptably high, the 9th Fundamental Traffic Safety Program is aiming to achieve the world's safest road traffic environment by 2015. It intends to accomplish this goal by reducing traffic accident injuries and fatalities from 900,000 (the level in 2010) to 700,000 through the adoption of even more positive measures to help reduce the number of injuries and fatalities, and by reducing the actual number of accidents that occur (the ultimate goal is to achieve zero traffic accidents). Active safety technologies are considered an important and effective means to help achieve this goal. Although the number of injuries and fatalities has fallen to 780,000 in the three years to 2013, further measures are still required.

Since virtually all traffic accidents are caused by human error, support for helping reduce driving error (i.e., errors in the cognition, decision making, and operation processes) will play an important role in reducing the number of accidents. Although conventional active safety technologies have focused on supporting the cognition and decision making processes through the provision of warnings, there is a growing trend toward supporting the operation process. The launch of low-speed automatic braking systems was a feature of 2013 and these systems have quickly gained widespread acceptance. Driving operation support is regarded as a potentially effective means of helping to prevent the growing number of accidents involving elderly drivers. For this reason, development in this field is likely to expand in the future. This expansion will depend on the development of high-performance technologies to achieve accurate sensing and reliable vehicle operation. At the same time, other key elements include interface technologies that accurately communicate the state of system support and desirable driver actions, as well as technologies capable of detecting the condition of the driver to accurately determine the timing and means of support.

3. 1. Sensor technology

Safe driving support requires the capability to accurately identify the conditions in a 360-degree range around the vehicle, including the presence of other vehicles, bicycles, motorcycles, pedestrians, buildings, and roads. Sensors capable of recognizing the environment around the vehicle include lasers (radio wave and optical), monocular and stereo cameras, and sonar. In addition to conventional scanning laser sensors, recent years have seen the rapid adoption of fixed-beam lasers for helping to avoid low-speed collisions. Multi-functional monocular cameras have been developed that can detect the distance to objects in some cases, as well as road markings. One advantage of stereo cameras is the capability to simultaneously recognize the distance to an object, as well as its size and shape. Color stereo camera systems can be used for traffic signal recognition. Sonar is suited for low-speed short-range direction and has been adopted for parking support systems. Current radar systems use the wide-range 24/26 GHz band to alert drivers when backing up and the 76 GHz band to detect objects at least 100 m ahead of the vehicle by scanning. In addition, next-generation 79 GHz ultra-wide band (UWB) technology is also being developed as a priority item.

Each technology is used in accordance with its advantages. At the same time, technology is also being developed to compensate for existing disadvantages. In the case of pedestrian protection, which is lagging behind other safety fields, it will be important to use sensors in accordance with the targeted function and purpose, as well as to develop ways of combining sensor technology (i.e., fusion systems).

One future issue for sensing technology is regions not directly visible by the driver (such as at night and outside the driver's field of view). It may be possible to help resolve this issue using the vehicle-to-vehicle (V2V) communication devices proposed by the NHTSA in the U.S., which is considering making the installation of these devices compulsory in the near future.

3. 2. Safety support systems

Safety support systems began to be adopted in vehicles from the second half of the 1990s. Various safety support systems were developed and adopted, including V2V distance warnings, lane departure warnings, adaptive cruise control (ACC), lane-keeping assistance, and collision damage mitigation brakes (i.e., pre-collision brake systems). However, at the time, these systems were limited to higher-end and luxury vehicles.

Against this trend, 2013 saw the rapid spread of low-speed automatic braking systems in mass-market and mini-vehicles. These systems have the attraction of being reasonably priced and easy to understand (i.e., customers can immediately grasp that the purpose of these systems is simply to stop the vehicle before a collision occurs). Since the development of safety support systems has conventionally been regulatory-based, this user-led demand has had a major impact. In the future, it will be necessary to accelerate the adoption and spread of safety systems from the dual standpoints of both regulations and user needs. In this way, it may be possible to come closer to an accident-free society.

In recent years, the mass-media has taken a close interest in certain major accidents that have been attributed to driver drowsiness or sudden-onset medical problems. The autonomous driving is the compilation of driving assist technologies. It is likely that the driving support functions and usage scenarios of autonomous driving systems will expand in the future, including the ability to take over control of the vehicle if the driver loses the capability to drive (i.e., a dead man's switch).

However, as safety technology advances, the scale of the overall vehicle system will expand, creating the need to consolidate configurations and functions. As these systems will directly control the basic driving, turning, and stopping functions of the vehicle, concerns have been raised about interference between systems (such as competition for the use of shared resources and dependent failures) and security (such as against computer viruses and hacking). Measures for these concerns will also be a critical research theme in the future.

4 Research and Technology Related to Post-Accident Safety

Statistics show that traffic accident fatalities are also declining in the U.S., Europe, and other developed countries and regions.

This trend is the result of a combination of factors such as enhanced vehicle safety, policies targeting the traffic infrastructure, drivers, cyclists, and pedestrians, as well as improvements in emergency care. To further reduce the number of traffic accident victims, various research is already under way to help improve post-accident safety by analyzing real-world traffic accidents and feeding back the results to safety technology.

4. 1. Biomechanics and crash test dummies

Crash test dummies that simulate vehicle occupants, and impactors that simulate the head and legs of pedestrians are important aspects of safety regulations and vehicle safety assessment collision tests. Various research is focusing on the development of more physically realistic biomechanical items, mainly dummies and impactors.

The mitigation of injuries to children and elderly people is of particularly concern in Japan, Europe, and the U.S. These countries are studying injury criteria as well as the introduction of more biologically faithful dummies. Although side-impact tests around the world currently use various different dummies, the Worldwide harmonized Side Impact Dummy (WorldSID) is being developed as a global standard dummy. A dummy with the average adult male physique has already been developed and studies are now examining test applications and the development of a dummy that simulates the characteristics of a smaller female physique. Development of the Test Device for Human Occupant Restraint (THOR) is also making progress as a frontal collision dummy with enhanced biological faithfulness. New injury criteria for the head and chest are being studied based on the results of real-world accident analysis. Additionally, in the case of leg impactors used for pedestrian protection evaluation, the new Flex-PLI developed by the Japan Automobile Research Institute (JARI) and the Japan Automobile Manufacturers Association (JAMA) was introduced into JNCAP in 2011. Discussions are being held about test applications with Euro NCAP and the World Forum for Harmonization of Vehicle Regulations (WP 29) under the auspices of the United Nations.

4. 2. Vehicle body development

In 2012, the IIHS in the U.S. started assessing safety using the small overlap test, which involves a collision between the front corner of a vehicle and an object. In this assessment, the barrier does not directly strike the area of the vehicle at which energy absorbing members (such as the front frame) are located. As a result, the deformation energy applied to the vehicle cabin is greater than in conventional tests and a stronger body structure is required for safety.

In general terms, although reinforcement is necessary to ensure that the body has high safety performance, this has the effect of increasing weight. As fuel economy standards become even more stringent in the future, technology capable of enhancing safety while reducing weight will become even more significant.

4. 3. Occupant protection systems

Seat belts and airbags are typical examples of occupant protection systems. Various technological innovations are being adopted to optimize occupant restraint forces in a collision, such as seat belt locking mechanisms on the buckle side and mechanisms that vary the propellant gas used for airbag deployment in accordance with the occupant. These technologies are aimed at occupants in the front seats. Adaptable seat belts have also been developed for rear seat occupants. These seat belts adjust the restraint force in accordance with the size of the occupant with the aim of helping to mitigate injury. In addition, a center airbag device was also launched as a new technology in 2013. This deploys in the event of a side impact to help stop the driver being forced in the direction of the passenger seat, thereby preventing contact with the interior structure or the occupant of the passenger seat.

4. 4. Rescue and relief systems

The 9th Fundamental Traffic Safety Program also describes the enhancement of rescue and emergency systems as a road traffic safety measure. One developed technology is automatic collision notification (ACN), which transmits the details of an accident automatically after it occurs. One commercial ACN service already available in Japan is called HELPNET. ACN devices can shorten the time required to communicate the accident details after an accident and should help to enhance the quality of first aid services.

Instead of a simple notification that an accident has occurred, research is also examining a new system called advanced automatic collision notification (AACN)

This system transmits detailed information such as the accident type and the impact speed, and uses the information to predict the extent of injuries, as well as to judge whether an air ambulance helicopter should be dispatched to the scene.