

Spotlight on
Highway Safety



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Bicyclist Safety

Prepared for
Governors Highway Safety Association

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Summary

The popularity of bicycling has drawn attention to methods for protecting bicyclists when they travel on public roads. Deaths of bicyclists in collisions with motor vehicles have decreased substantially in the United States (U.S.) in recent decades, along with motor-vehicle related deaths in general. However, between 2010 and 2012, U.S. bicyclist deaths increased by 16 percent, from 621 in 2010 to 680 in 2011 and 722 in 2012. Other motor vehicle fatalities increased by one percent during this same time period. Every year since 1975, bicyclist deaths have comprised 2 percent of all motor vehicle deaths nationwide.

Between 2010 and 2012, six states – California, Florida, Illinois, New York, Michigan, and Texas – accounted for 54 percent of all bicyclist deaths in collisions with motor vehicles. California (338) and Florida (329) had the highest totals, as well as the largest increases (Florida, +37; California, +23) in bicyclists killed. In 2012, Florida had the highest proportion of motor vehicle related deaths that were bicyclists (5 percent), followed by California (4.3 percent) and Massachusetts (4.3 percent).

In many states, bicyclist deaths in collisions with motor vehicles are infrequent. Twenty-three states averaged five or fewer deaths per year between 2010 and 2012, and in 11 states and the District of Columbia there were five or fewer total bicyclist deaths.

Fatal bicyclist crash patterns have changed markedly. The percentage involving adults age 20 and older increased from 21 percent in 1975 to 84 percent in 2012. The percentage involving males increased from 82 percent to 88 percent during this period. Adult males comprised 74 percent of all bicyclist deaths in 2012. The percentage of deaths occurring in urban areas climbed from 50 percent in 1975 to 69 percent in 2012.

Lack of helmet use and alcohol impairment have been and continue to be major contributing factors in bicyclist deaths.

States rely on education and enforcement to encourage motorists and bicyclists to obey traffic laws and be courteous and alert. In terms of integrating motor vehicles and bicyclists on the roads, total physical separation is preferable. Where this is not possible, the goal is to reduce the time or distance in which bicyclists are exposed to risk via marked bike lanes, bicycle boulevards, separate bicycle traffic signals, and other techniques. These treatments can be supplemented by methods to slow motor vehicles down, and roadway lighting and warning signs to increase awareness of the presence of bicyclists.

In many states and urban areas, engineering measures are being adopted to accommodate bicycles on the road, with the dual aim of protecting cyclists from collisions with motor vehicles, while encouraging cycling for its health and environmental benefits.

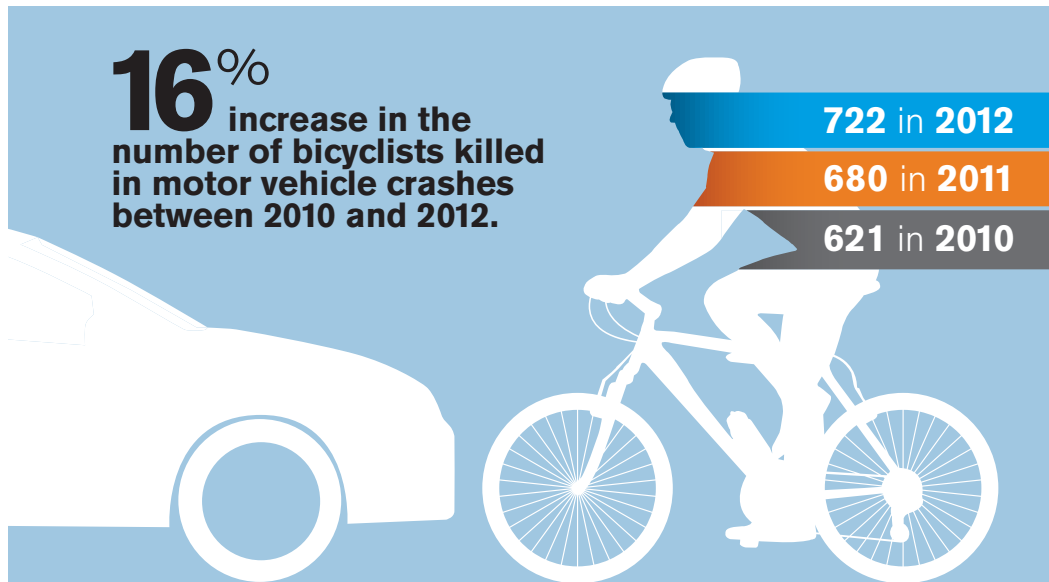
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Introduction

Bicycling for recreation, exercise, and basic transportation is being heavily promoted in the United States for its health and environmental benefits. To the extent bicycling (or walking) replaces motor vehicle travel, congestion and greenhouse gas emissions are reduced. The health risks associated with physical inactivity and obesity are well established, and biking provides a way to combat these dangers. However, biking has its own health risks when it occurs on roads shared with motor vehicles.

Bikers (and walkers) are frequently classified as “vulnerable road users.” The biking community, however, is not comfortable with the term, preferring instead references such as “green” or “environmentally sound” (Cynecki, 2012). Yet because of differences in mass and the lack of a protective structure, when bicycles collide with motor vehicles, the risk is asymmetric. Bicyclists are susceptible to serious injury; motorists are not (Ragland, 2012). The elevated risk of injury to bicyclists when they encounter motor vehicles makes it important to identify and implement strategies to protect cyclists on the road. There is some evidence that bicycling has increased in recent years. But even with widespread encouragement, many will be deterred from biking if they do not feel safe (Jacobsen et al., 2009).

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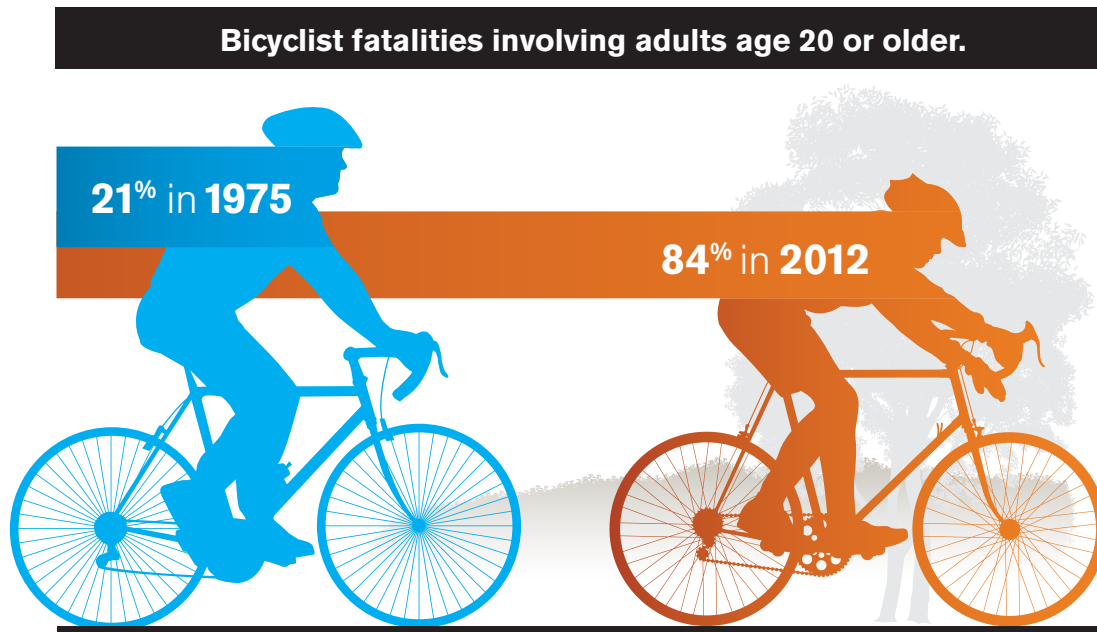
Exposure and Fatality Trends

Adequate exposure data are not available to accurately monitor changes in bicycle travel, and nationally representative surveys of the U.S. adult population conducted in 2002 and 2012 provide mixed evidence. The percentage who said they never biked in the summer months increased from 57 percent in 2002 to 66 percent in 2012, although a greater percentage in 2012 said they had done more biking in the past year than those surveyed in 2002 (Schroeder & Wilbur, 2013). Evidence from other sources suggests that biking is increasingly popular, particularly for commuting, although far less so in the U.S. than in other countries (McKenzie, 2014).

Changes in exposure may be reflected in recent trends in bicyclist deaths. Bicyclists killed in motor vehicle crashes increased from 621 in 2010 to 680 in 2011 and 722 in 2012, an overall increase of 16 percent. These counts are based on the Fatality Analysis Reporting System (FARS), as reported by the Insurance Institute for Highway Safety (2014). During this interval, all other motor vehicle deaths increased one percent. To the extent encouragement of bicycling is successful, exposure and fatalities are likely to continue to increase.

Notably, current yearly deaths of bicyclists are among the lowest since 1975, when FARS data were first compiled. The highest annual total (1,003) occurred in 1975. Yearly deaths averaged 933 from 1975 to 1979, 889 in the 1980s, 792 in the 1990s, and 696 from 2000 to 2012. The 621 deaths in 2010 were the lowest in the 38 years of FARS. Motor vehicle deaths in general have decreased over this period, and the percent of deaths that are bicyclists has not increased since 1975. Bicyclists have accounted for about 2 percent of total fatalities each year, ranging from 1.5 to 2.3. In 2012 they represented 2.2 percent of all motor vehicle-related deaths.

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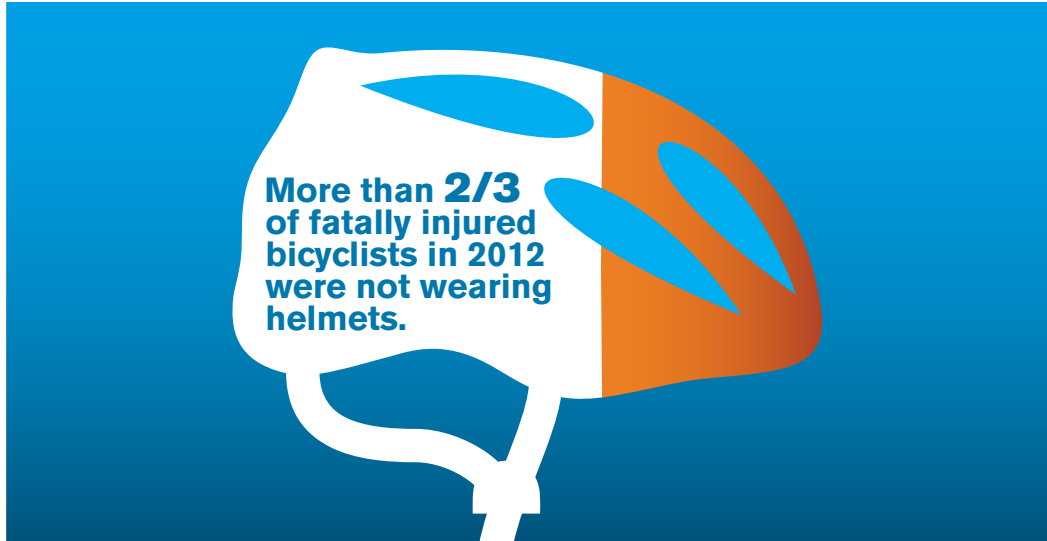
Crash Patterns

During the period in which FARS data have been available, there have been some remarkable changes in bicyclist crash patterns, especially related to age and location. From 1975 to 2012, the percentage of fatally injured bicyclists younger than 20 decreased from 79 percent of the total to 16 percent, while the percentage of adults 20 and older increased from 21 percent to 84 percent. Based on the General Estimates System, a sample of police reported crashes in the U.S., the National Highway Traffic Safety Administration (NHTSA) reported 49,000 injuries in motor vehicle/pedalcycle collisions in 2012 (includes a small number of unicycles and tricycles) (NHTSA, 2014). Of this total, 34 percent of the deaths involved bicyclists younger than 21, compared with 50 percent in 2003.

The percentage of fatally injured bicyclists who are males has grown from 82 percent in 1975 to 88 percent in 2012. Adult males are an important target group. Males age 20 and older accounted for 74 percent of all bicyclist deaths in 2012, followed by males younger than 20 (14 percent), females 21 and older (10 percent), and females younger than 20 (2 percent).

Bicyclist deaths are also increasingly likely to occur in urban areas, with the proportion increasing from 50 percent in 1975 to 69 percent in 2012. In 2012, 37 percent of the deaths occurred at intersections.

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Bicycle Helmet Use

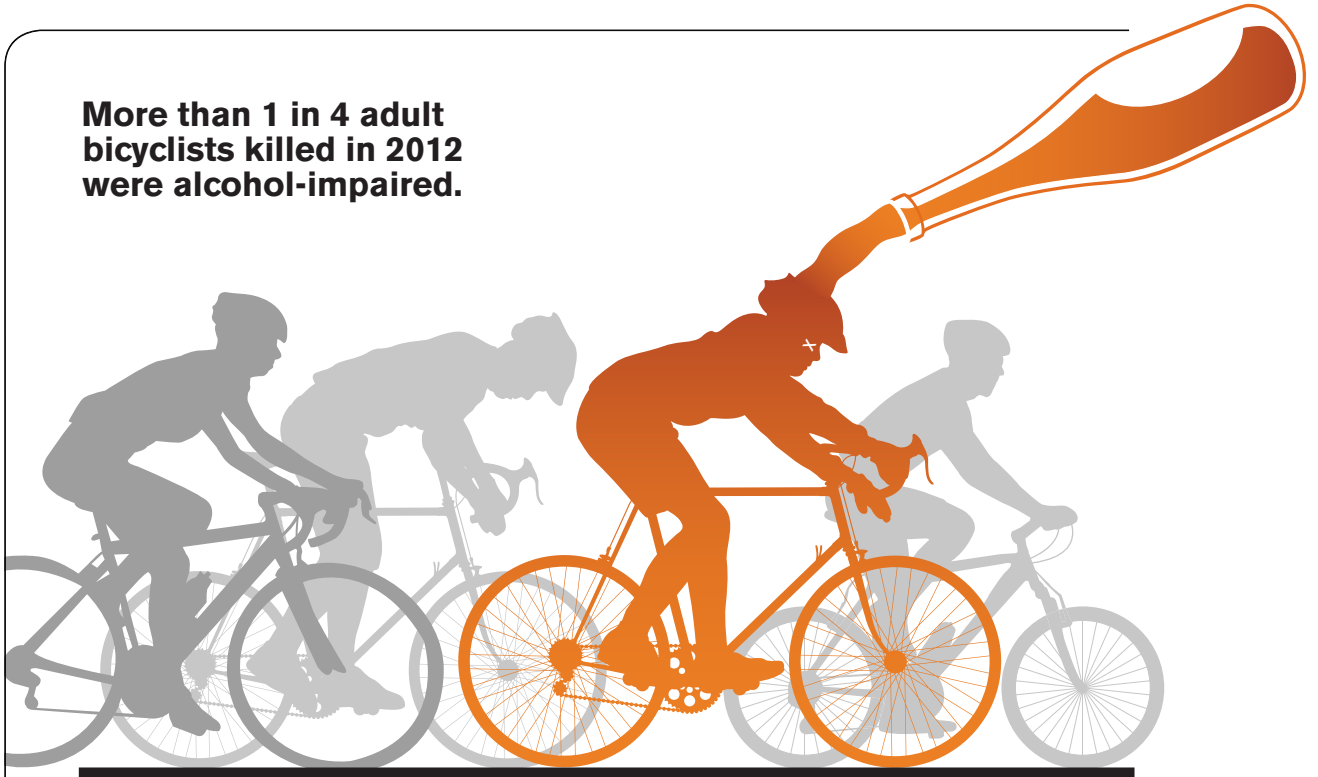
Lack of helmet use is a major contributing factor in fatalities. Many deaths involve serious head injury. Helmets are effective in reducing head injuries (Haworth et al., 2010; Bambach et al., 2013; Otto & Wiese, 2014), although improper fit and positioning can lessen their effectiveness (Hagel et al., 2010). However, many bicyclists do not wear helmets. In the 2012 national survey of U.S. adults, 46 percent of bicyclists said they never wore them (Schroeder & Wilbur, 2013). In 2012, FARS data indicated that 17 percent of fatally injured bicyclists were wearing helmets, 65 percent were not, and helmet use was unknown for 18 percent.

Twenty-one states and the District of Columbia (D.C.) have helmet use laws for children. No state mandates adult helmet use, although in some localities helmets are required for bikers of all ages. There is evidence from Australia and Canada that laws covering adult bikers increase use and reduce injuries (Karkhaneh et al., 2001; Macpherson & Spinks, 2008; Olivier et al., 2013; Dennis et al., 2010; Walter et al., 2011). According to the 2012 national survey, 63 percent favor universal helmet laws (Schroeder & Wilbur, 2013). In Canada, it was reported that helmet use by young cyclists was significantly higher in a province with a universal law than in a province requiring only those younger than 18 to be helmeted (Dennis, et al., 2010).

However, helmet laws for adult cyclists are controversial, and they are opposed by some biking organizations. Some of the reasons given for opposing laws involve challenges as to how effective they would be. The central reason appears to be the concern that laws would discourage people from biking (Pless, 2014). However, the existing literature suggests that this is not the case (Dennis et al., 2010; Olivier et al., 2013), or that any drops in cycling are temporary (Finch et al., 1993; VicRoads, 2014). The lack of universal helmet use laws for bicyclists is a serious impediment to reducing deaths and injuries, resulting from both collisions with motor vehicles and in falls from bicycles not involving motor vehicles.

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More than 1 in 4 adult bicyclists killed in 2012 were alcohol-impaired.



Alcohol Use

Despite the association of biking with healthy lifestyles and environmental benefits, a surprisingly large number of fatally injured bicyclists have blood alcohol concentrations of 0.08% or higher. This was the case for 28 percent of those aged 16 and older in 2012, just a few percentage points lower than for passenger vehicle drivers with high BACs (33 percent). The percentage of bicyclists with high BACs has remained relatively constant from 1982 to 2012, ranging from 23 percent to 33 percent. Of note is the fact that between 1982 and 1992, the percentage of high BACs among bicyclists changed little, but dropped sharply for passenger vehicle drivers.

A recent study of alcohol in fatally injured bicyclists indicates that from 2007 to 2011, 25 percent had BACs of 0.08% and above and 19 percent had high BACs of 0.15% or greater (compared with 25 percent of passenger vehicle drivers fatally injured) (Eichelberger, Cicchino, & McCart, 2013). High BAC bicyclist deaths were most likely to occur between 9 p.m. and 3 a.m. and involve drivers ages 30 to 49.

NHTSA (2014) presents alcohol information in terms of both the driver of the motor vehicle and the bicyclist. In 32 percent of the crashes in 2012, either the driver or the cyclist were reported to have a BAC of 0.08% or higher.

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Bicyclist Fatalities by State

There is great variation among states in the number of bicyclist deaths.

Table 1 displays deaths by state and D.C. for 2010, 2011 and 2012, and changes from 2010 through 2012.

Between 2010 and 2012, the greatest numbers of bicyclist deaths occurred in high population states with many urban centers: California (338), Florida (329), Texas (143), New York (138), Illinois (80), and Michigan (72). These six states accounted for more than half (54 percent) of all bicyclist fatalities during this time period. This likely reflects the amount of bicycling exposure and interaction with motor vehicles in these states. Table 1 indicates that during the three-year period from 2010 to 2012 in which bicyclist deaths were increasing nationwide, almost half the states (23) averaged five or fewer deaths per year, and 11 states and D.C. had fewer than five total deaths during this period. In one or more years, 14 states had zero bicyclist deaths. Vermont and Wyoming had the fewest numbers of deaths (one per state) in the three-year-period.

Between 2010 and 2012, deaths increased in 22 states, decreased in 23 and D.C. and stayed the same in five. That is, less than half the states had increases in deaths over this period when deaths were increasing nationally. This is due to a few states having large increases, especially in Florida (+37) and California (+23). There were also double-digit increases in Texas (+14) and Louisiana (+12). The largest decrease was in Michigan (-10).

Another way to consider state variation is in terms of the proportion of all motor vehicle-related deaths in that state that were bicyclists. In 2012, 2.2 percent of all deaths nationwide were bicyclists. In 16 states, bicyclists represented less than one percent of all deaths. In 20 states, they accounted for 1 to 1.9 percent of all deaths; between 2 and 2.9 in six states; and 3 or greater in nine. The states with the highest rates of bicyclist deaths were Florida (5 percent), California (4.3 percent), Massachusetts (4.3 percent), and New York (3.9 percent).

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Table 1:
Bicyclist Deaths 2010-2012
by State, and Changes
During that Period

State	2010	2011	2012	2010-2012 Change
Alabama	6	5	9	+3
Alaska	0	2	1	+1
Arizona	19	22	18	-1
Arkansas	2	6	6	+4
California	100	115	123	+23
Colorado	8	8	13	+5
Connecticut	7	8	4	-3
Delaware	2	0	4	+2
DC	2	1	0	-2
Florida	83	126	120	+37
Georgia	18	14	17	-1
Hawaii	3	2	2	-1
Idaho	4	0	2	-2
Illinois	24	27	29	+5
Indiana	13	11	15	+2
Iowa	8	5	3	-5
Kansas	1	2	7	+6
Kentucky	7	2	6	-1
Louisiana	11	18	23	+12
Maine	1	0	1	--
Maryland	8	5	5	-3
Massachusetts	7	5	15	+8
Michigan	29	24	19	-10
Minnesota	9	5	7	-2
Mississippi	4	7	4	--
Missouri	7	1	6	-1
Montana	0	1	1	+1
Nebraska	2	2	0	-2
Nevada	6	4	3	-3
New Hampshire	0	4	0	--
New Jersey	13	17	14	+1
New Mexico	8	4	7	-1
New York	36	57	45	+9
North Carolina	23	25	27	+4
North Dakota	1	1	0	-1
Ohio	11	16	18	+7
Oklahoma	9	1	5	-4
Oregon	7	15	10	+3
Pennsylvania	21	11	16	-5
Rhode Island	2	0	2	--
South Carolina	14	15	13	-1
South Dakota	2	1	0	-2
Tennessee	4	5	8	+4
Texas	42	45	56	+14
Utah	7	5	3	-4
Vermont	1	0	0	-1
Virginia	12	6	11	-1
Washington	6	11	12	+6
West Virginia	2	0	1	-1
Wisconsin	9	12	11	+2
Wyoming	0	1	0	--
TOTAL	621	680	722	+101

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Actions to Reduce Collisions and Injuries

Approaches to reducing bicyclist/motor vehicle collisions and the resulting injuries and fatalities include:

- laws and their enforcement;
- education of bicyclists and motorists about lawful and otherwise appropriate behavior regarding motorist/bicyclist interactions;
- infrastructure changes to facilitate road sharing;
- efforts to increase bicycle helmet use and the conspicuity of bicycles and bicyclists;
- techniques to decrease motor vehicle speeds; and
- measures to reduce alcohol-impaired vehicle operation by bicyclists and motorists.

There are laws governing interactions between bicycles and motor vehicles on the road. Bicyclists are required to follow the same rules as other vehicle operators, including obeying traffic laws and traveling in the same direction as motor vehicles. Motor vehicle operators are subject to these same rules, and in some jurisdictions there are special laws, such as motorists giving bicyclists at least three feet of clearance when passing. It is important that motorists be aware of bicycles not only while they are driving, but also when exiting a car to prevent opening the door on a bike. Education and law enforcement programs addressing both motorists and bicyclists have been used to encourage compliance.

Appropriate and lawful behavior on the part of bicyclists and motorists would increase safety and help to reduce the tensions that can result when they share the same space. For this reason, information about relevant laws and best practices regarding bicycle and motor vehicle interactions should be covered in driver manuals, driver education courses, and written tests.

Environmental and engineering changes are being implemented to accommodate bicycles and motor vehicles traveling in the same direction, and at intersections, where 37 percent of bicyclist deaths occurred in 2012. Ideally a “Complete Streets” approach is adopted with the goal of providing safe and convenient access for all roadway users. In addition to targeting individual roads, a key aspect of this approach is connectivity among destinations. In mixed-use developments, for example (which are generally smaller, denser neighborhoods) homes, schools, stores and transit are within walking or bicycling range, making for “Livable Streets.” A “Complete Streets” approach can be undertaken in existing neighborhoods, and more systematically accomplished in new developments.

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Roads were built to accommodate motor vehicles with little concern for pedestrians and bicyclists. Integrating motor vehicles and bicycles in already-built environments presents challenges. The most protective way to accomplish this is through total physical separation of bicycles and motor vehicles. Research confirms that “cycle paths,” which do this, provide the best safety (Teschke, 2012), but they are rarely feasible. When physical separation cannot be accomplished, the goal is to reduce the distance or time in which bicyclists are exposed to risk (Ragland, 2012). This can be accomplished via:

- marked bike lanes;
- bicycle boulevards, a network of traffic-calmed roads that parallel urban arterials;
- bike boxes, a space in a lane before an intersection solely for bikes, generally placed to the right in front of the queue, providing bicycle visibility and protection against cars turning right across the bike's path; and
- separate bicycle traffic signals with advance green lights for cyclists.

These treatments can be supplemented by measures to slow down vehicles, and special signs and lighting to enhance visibility. Slowing down vehicles is important for reducing collisions and their severity and can be accomplished in various ways. For example, New York City recently established “slow zones” in residential areas. Identified by a prominent blue gateway on all streets leading into the zone, they feature reduced speed limits from 30 mph to 20 mph, speed bumps and special signing (New York City Department of Transportation, 2012).

Enhancing visibility through reflective clothing and lighting is also important, especially since many collisions take place in periods of darkness. In 2012, 27 percent of bicyclist deaths happened between 9 p.m. and 6 a.m. A Danish study found that the provision of permanent daytime running lights decreased crashes by 17 percent compared with a control group without these lights (Madsen et al., 2013).

One of the most important steps bicyclists can take is to wear helmets and wear them properly. In the absence of universal helmet use laws, reliance has to be placed on persuasive efforts to encourage this practice. Since alcohol use is an important significant factor in bicycle/motor vehicle collisions, efforts to reduce alcohol-impaired driving by both bicyclists and motorists warrants emphasis.

Vehicle-related changes may also reduce bicyclist injuries. For example, more vehicles are being equipped with technology that detects pedestrians and bicycles and automatically brakes the vehicle (Jermakian & Zuby, 2011).

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Current State Emphasis

Many large cities such as Chicago, New York, Portland, San Francisco and Washington, D.C., and urban areas near these cities, are taking steps to encourage biking and to protect bicyclists on the roads. To determine how states with large numbers of bicyclist deaths are addressing the problem, GHSA surveyed the state highway safety offices in California, Florida, Illinois, Louisiana, Michigan, New York, North Carolina, Ohio, Pennsylvania and Texas. Two questions were posed: “What do you think is necessary for furthering the protection of bicyclists, and what is your state doing in this regard?” and “Are you planning new programs or increased emphasis on bicyclist safety?”

Survey responses received from the 10 states confirmed that bicyclist safety is being given considerable attention, despite its small contribution to overall motor vehicle-related fatalities. One state pointed out that the bicycle safety problem is “tiny” compared to alcohol, teen drivers, motorcycles, and other issues, and that there was “no justification for spending additional resources on a problem that is so small, relatively speaking.” However, all states are actively promoting safe bicycling, and some are making special efforts to collect information on bicycle crash patterns and locations. That is essential for making informed decisions about countermeasures and resource allocation. California, for example, is taking the lead in developing and implementing bicycle exposure measures to help engineers determine where attention is needed.

All states are leveraging the three E's of traffic safety – education, enforcement and engineering – to address bicyclist safety. Educational efforts primarily address laws pertaining to bicycle travel on public roads, motorist obligations and “share the road” messages. The importance of helmet use for both children and adults is also a feature of many educational initiatives. New York supplements this message by sponsoring bicycle helmet distribution programs and proper fit training.

State programs also focus on conspicuity issues. Michigan noted that motorists who collide with bicycles often indicate they did not see them, prompting the promotion of high visibility riding gear. In Florida, police officers are stopping bicyclists who ride without lights at night, distributing lights to those who are less able to afford them, and affixing the light to the bike.

Enforcement of laws involving bicycle riding on public streets and motorist behavior was mentioned in almost all states. Florida has designated \$1.5 million for high visibility enforcement programs aimed at motorists and bicyclists who violate traffic laws.

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Ohio is actively promoting its nearly 250 miles of state park bike systems and extensive network of trails for bicyclists (“Rails to Trails”) totaling more than 124 miles. However, many bicyclists want to use public roads for commuting and other transportation purposes, and infrastructure changes to better accommodate bicycles on the roads were often mentioned. Several states indicated that they have adopted Complete Streets policies to ensure safe travel for all roadway users. New York is increasing the provision of interconnected bicycle facilities such as protected bike lanes, bike paths, bicycle-friendly shoulders, innovative pavement markings and signage such as bike boxes and sharrows (shared roads where bicyclists can use the full lane). Marked bike lanes are the most common treatment, but how they accommodate cyclists may differ in terms of their width and whether there are parked cars on their right, making bicyclists susceptible to door-opening collisions.

Research indicates that bicyclists prefer separate street facilities over purely recreational paths (Nuworsoo & Cooper, 2013) and states are responding by attempting to improve on-road bike lane safety. For example, Illinois is piloting a barrier-protected bike lane. In Washington D.C., two innovative treatments have been instituted – a buffered center median bike lane and a two-way cycle track (Goodno et al., 2012). Both treatments, which involve dedicated road space with buffers between bicycles and motor vehicles, have increased bicycle use. Notably, when new bicycle facilities are instituted, they need to be accompanied by educational programs aimed at both motorists and bicyclists. These programs should not only address right-of-way issues, but also encourage input from users to determine acceptance of the facilities and any problems they may encounter.

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Discussion

Bicycling is being aggressively promoted as an alternative to motor vehicle use, and its popularity appears to be increasing. The potential health and environmental benefits that could result from increased bicycling make it attractive. However, there are potential health hazards for bicyclists when they are on the road with motor vehicles. Increasing bicyclists' protection serves the dual purpose of making biking safer and inducing more people to cycle. At the same time, it is notable that bicyclist deaths are a minor contributor to overall motor vehicle-related deaths and a rare occurrence in many states. This suggests the need for balance in addressing the problem vis-à-vis other highway safety issues, as well as a focus on those states and locations within states where bicycle/motor vehicle collisions most often occur.

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