

Traffic safety in the context of public health and medicine

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Today we can prevent, treat, or cure most of the deadliest diseases known to humankind—and yet more than a million people around the world die every year—42,000 in the U.S. alone—from traffic injuries (Sleet, Dinh-Zarr, and Dellinger 2007).

Overview

Considering motor vehicle injuries in the context of other preventable causes of death and disease helps make motor vehicle injury a salient issue in public health and preventive medicine. Framing the motor vehicle injury problem as a predictable and preventable public health problem offers health practitioners a tool to persuade the public and policy makers alike that this is an unrecognized health problem that is amenable to change. Public health's long history in advocacy for milk pasteurization, chlorination of drinking water, and other environmental safeguards can be extended to building safer roads and vehicles. The promotion of lifestyle change to reduce smoking, heart disease, and cancer prevention, can have the same appeal for changing the safety behaviors of drivers, pedestrians, and cyclists. Stimulating a culture of safety means providing safe and accessible transportation for all as a means to improve the overall quality of life for populations.

Introduction

The health of Americans changed significantly during the 20th century. In 1900, the leading causes of death were respiratory infections and diarrhoeal diseases (Ward and Warren 2007). Other infectious diseases, such as smallpox and poliomyelitis, were a constant source of dread. Public health and medical advances during the first half of the 20th century led to a dramatic fall in the death rate due to infectious diseases. Today, widespread immunization programs have virtually eliminated the threat of diseases, such as polio, diphtheria, and measles. As public health and medicine began to control infectious diseases, chronic diseases and injuries emerged as leading causes of death. Among the most important of these injuries were those related to motor vehicle travel.

This paper defines public health, describes the transportation and public health perspectives of motor vehicle safety, outlines current efforts to integrate traffic safety and public health activities in the context of a culture of safety, and discusses future research needs as transportation, public health and medicine collaborate to create a culture of safety.

Defining traffic safety as a public health problem

Public health is the science and practice of protecting and improving the health of *communities* through education, promotion of healthy lifestyles, and research on disease control, health promotion, and injury prevention. Public health prevention measures and programs to date have been credited with 25 of the 30-year increase in life expectancy since 1900. Public health takes credit for 900,000 fewer cases of measles from 1941 to 1996; for 42 million fewer smokers from 1965 to 1996 (Association of Schools of Public Health 2006); and for saving millions of Americans who might otherwise have died from chronic diseases or injury. The three core functions of public health are consistent with efforts to reduce motor vehicle injury:

- monitor and evaluate the health needs of communities
- promote healthy practices and behaviors in populations; and
- identify and eliminate environmental hazards to assure that populations remain healthy.

From the standpoint of preventable morbidity and mortality, public health has much to offer traffic safety. Public health has resources, skilled workers, and close connections to the community on matters related to health promotion and disease prevention. These features can help reduce motor vehicle injury, but only if society recognizes that injuries, like diseases, are predictable and preventable.

Motor vehicle injuries remain an enormous public health problem (Institute of Medicine [IOM] 1999). In the last 100 years, more than 2.8 million persons have died, and nearly 100 million persons have been injured on U.S. roads and highways (Department of Health and Human Services 1992). Currently, traffic injuries are the leading cause of death for children, adolescents, and young adults, and a major cause of death for all other ages. In 2005, motor vehicle crashes led to 43,443 deaths and about 2.7 million non-fatal injuries associated with more than 6 million police-reported crashes (National Highway Traffic Safety Administration [NHTSA] 2006). Motor vehicle injuries accounted for 22% (\$89 billion) of the total lifetime costs of all injuries in 2000 (Finklestein, Corso, and Miller 2006). Blincoe et al. (2002) estimated that motor vehicle-related costs are equivalent to about \$820 for each man, woman, and child in the U.S. per year and is 2.3% of the U.S. gross domestic product. Motor vehicle crash injuries on and off the job cost employers almost \$60 billion (Network of Employers for Traffic Safety 2006).

Although motor vehicle crashes clearly have a health impact on individuals and society, traffic safety is often considered a transportation concern rather than a public health problem. Progress in traffic safety will be limited if this attitude prevails. As the World Health Organization attests,

road safety should be viewed as a shared responsibility and not the exclusive purview of a single agency (Peden, Scurfield, Sleet, et al. 2004). Traffic crashes affect not only transportation systems, but also affect economic systems, health systems, jobs, families, and civil society. A culture of safety implies a systematic commitment by institutions, agencies, organizations, and individuals to recognize and address the unacceptable road toll and apply the best prevention strategies known to reduce it. As C. Everett Koop, MD, former US Surgeon General said about childhood injuries, “If a disease were killing our children in the proportion that accidents are, people would be outraged and demand this killer be stopped” (National SAFE KIDS Campaign 2006). This is the vision for a culture of safety—to change the public’s attitude about the unacceptable toll from traffic injuries and thereby increase our nation’s priority for road safety as a means of prevention. This action should be a social imperative.

The public health response to traffic injuries has come from different quarters—the medical profession, public health organizations, consumer advocates, and the federal health sector. The U.S. Public Health Service (PHS), part of the Department of Health and Human Services, has taken the lead within the federal health sector. Because of the enormous demands traffic injuries place on the health care system, and the significant impact of prevention programs, the PHS got involved early in the century and has since played a critical role in organizing the public health response through epidemiology, intervention and prevention programs, public education and training, trauma care, and rehabilitation.

100 years of motoring: Uncovering the risks and protecting the public

Unlike other public health problems of the early 20th century, motor vehicle injuries and deaths are attributable to the development and rapid adoption of a new technology—the motor vehicle. In 1900, motor vehicle travel was a novelty and the risks to health and safety were largely overlooked. At that time, the motor vehicle was a major improvement over other modes of personal travel (e.g., the horse and buggy), and subsequent improvements in manufacturing made cars more affordable and available benefiting commerce, communications, and personal mobility. In 1900, an estimated 8,000 automobiles were registered in the United States. By 1950, the number of automobiles had grown to 50 million. By 2001, more than 230 million vehicles were registered, 193 million drivers were licensed and sharing roadways with an untold number of cyclists, pedestrians, and vehicle occupants. This rapid “motorization” of America brought with it increased exposure to potential risks for crashes and injuries to drivers, passengers, pedestrians, and cyclists (Global Traffic Safety Trust 1998). Over the years there were more drivers traveling roads more frequently, causing a sharp increase in deaths and injuries on the road—from 1.0 motor vehicle death per 100,000 population in 1900 to a peak of 31.0 in 1937 (National Safety Council 2002). In other words, increased mobility brought with it declines in safety. This is the paradox of motor vehicle travel in the United States and a growing problem worldwide.

The transportation perspective

The adverse consequences of increased motorization in the first few decades of the 20th century led President Herbert Hoover to convene the first National Conference on Street and Highway Safety in 1924. This was the first in a series of presidential initiatives to create a uniform set of traffic laws designed to prevent collisions and protect the public from unnecessary death and injury (American Public Health Association 1961). During 1924–1934, physicians and health practitioners participated in the national program, and formal committees were developed in all areas of traffic safety. Yet, traffic deaths continued to climb as drivers and vehicles were exposed to risks increased faster than the safety countermeasures could be designed and delivered. In 1934, 36,101 traffic-related deaths were reported (28.6 per 100,000 population). These numbers prompted President Franklin D. Roosevelt to enlist the cooperation of the governors in each of the 48 states to reduce the traffic-injury problem. In a letter to each governor on January 23rd, 1935, Roosevelt (1935) began by saying:

“I AM GRAVELY CONCERNED WITH THE INCREASING NUMBER OF DEATHS AND INJURIES OCCURRING IN AUTOMOBILE ACCIDENTS. PRELIMINARY FIGURES INDICATE THAT THE TOTAL OF THESE LOSSES DURING THE YEAR 1934 GREATLY EXCEEDED THAT OF ANY PREVIOUS YEAR. WE SHOULD, AS A PEOPLE, BE ABLE TO SOLVE THIS PROBLEM WHICH SO VITALLY AFFECTS THE LIVES AND HAPPINESS OF OUR CITIZENS.”

This pronouncement and plea for involvement in traffic safety was perhaps the beginning of a culture of traffic safety in the United States. Roosevelt’s letter (and subsequent action by state governors), was the genesis of the present-day Governor’s Offices of Highway Safety which exist in every state to assist efforts to improve traffic safety.

In response to rising motor vehicle death rates in the early 1960s and the climate of social reform, President Lyndon B. Johnson signed two Acts in 1966: the Traffic and Motor Vehicle Safety Act and the Highway Safety Act. These Acts paved the way for an intensified effort by the government to set and regulate standards for motor vehicles and highways and to improve safety for drivers, passengers, pedestrians, and cyclists (Transportation Research Board [TRB] 1990). This legislation led to the creation of the National Highway Safety Bureau (NHSB), which in 1970 became the National Highway Traffic Safety Administration (NHTSA). Beginning with 1968 models, these two Acts gave the NHSB/NHTSA the authority to set safety standards for highways and new cars.

The systematic approach to motor vehicle-related injury prevention began with NHSB's first director, William Haddon (Institute of Medicine 1985). Haddon, a public health physician and epidemiologist, articulated a scientific approach to the prevention of motor vehicle injuries rooted in public health (Haddon 1968). Haddon’s concept was built upon the work of Dr. John E. Gordon who suggested that injuries behaved like classic infectious diseases and were characterized by epidemic episodes, seasonal variation, and long-term trends. “Most important, each injury, like each disease outbreak, was the product not of one cause but of forces from at least three sources, which are the host...the agent itself, and the environment in which host and agent find themselves” (Gordon 1949). Haddon further described the factors contributing to motor vehicle injury as occurring during three phases: the pre-crash phase, crash phase, and post-crash phase (Haddon 1968). NHTSA’s activities today continue to be influenced by Haddon’s

work and emphasize the importance of gaining a better understanding of the interaction between the driver, vehicle, and roadway environment.

Because of NHTSA's regulations, manufacturers began building vehicles with improved safety features such as head rests, energy-absorbing steering wheels, rollover protection, dual brakes, shatter-resistant windshields, and safety belts (TRB 1990; Rice et al. 1989). Multiple strategies were used to improve roads (i.e., environments) including better delineation of curves; the addition of edge and center-line stripes and reflectors, breakaway signs and utility poles, and highway illumination; the use of barriers to separate traffic lanes, guardrails, and grooved pavement to increase tire friction in bad weather; the practice of channeling left-turn traffic into separate lanes; the addition of rumble strips; and the availability of crash cushions on exit ramps (Department of Health and Human Services 1992; Waller 1985; Rice et al. 1989). And with time, the behavior of drivers and passengers (i.e., the host factors) changed to reduce risks related to safety belt use, drinking and driving, and speeding (i.e., the human factors) (Shinar 1978; Evans 1991). Enactment and enforcement of stricter traffic safety laws, reinforced by public education, led to personal choices favoring safety (e.g., avoiding impaired driving, waiting until age 21 to purchase alcohol, reducing speed, wearing helmets, and using child safety seats and safety belts) (Dellinger, Sleet, and Jones 2007).

Governmental recognition of the public health threat posed by motor vehicles prompted federal and state governments, academic institutions, community-based organizations, and industry to initiate safety programs. From the transportation side, NHTSA and the Federal Highway Administration (FHWA), part of the U.S. Department of Transportation, have provided national leadership for traffic and highway safety efforts related to vehicles, driver behavior, and road environments since the 1960s—activities which continue to benefit safety today (Institute of Medicine, 1999). Among the improvements in roads, the FHWA was charged with developing national standards for all traffic-control devices on any street, highway, or bicycle trail open to public travel (Federal Highway Administration 2003). Had it not been for these efforts at the Federal level to design and implement actions supporting a culture of motoring safety, the US traffic injury and death rates would surely be higher than they are today.

The public health perspective

The public health model for prevention has been applied to a wide variety of infectious and chronic diseases with remarkable success. Although many scientific disciplines, such as engineering, environmental health, and emergency medicine, have advanced our understanding of motor vehicle injury, its causes and consequences, public health has introduced the tools, methods, applications, and systems previously missing (Sleet 1987).

By definition, public health is not about individual patients—it is about populations. Public health focuses on the continuous monitoring of health, on identifying, preventing, and managing diseases and conditions affecting health, with the aim of maximizing benefits for the entire population. This is what makes public's health contribution to society unique. By necessity, public health must draw from many disciplines, such as epidemiology, health services, health promotion, behavioral science and health education, statistics, economics, and medical

sociology. Unique strengths of public health include its connectedness to the community, its ability to approach health problems through a coordinated system of care, and its population focus. The population focus alone helps in the development of tools and methods used to identify, prevent, and treat illness, disease, and injury. These characteristics are embedded in the public health culture and can be successfully applied (or adapted) to the “disease” of traffic injury and to the promotion of safety.

Public health can effectively use these tools and its national infrastructure to identify, track, and monitor traffic injuries and deaths and to design short- and long-term solutions to help counter the rising exposure to traffic injury. One important tool in the fight against traffic injuries has been the use of the classic epidemiologic triad used to characterize the causal nexus of disease. This triad of host (the person affected), agent (the causative element and the vehicle or vector carrying it), and the environment (conditions in which the host and agent find themselves) can be used to explain the development of smoking-related diseases as well as the factors contributing to traffic-related injury (see Figure 1). Injury results from the interaction between injury-producing **agents** (for example, kinetic energy transferred to the host when a speeding car crashes), **host** factors (a young, inexperienced driver or drinking driver), and the **environment** (road surfaces, signs, weather). Intervening on the host (changing behaviors to reduce risk), on the agent (changes in vehicle design to reduce energy transfer), or on the environment (installing dividing barriers and guardrails) can singly, or in combination, reduce the likelihood of both a crash and of the injuries that result.

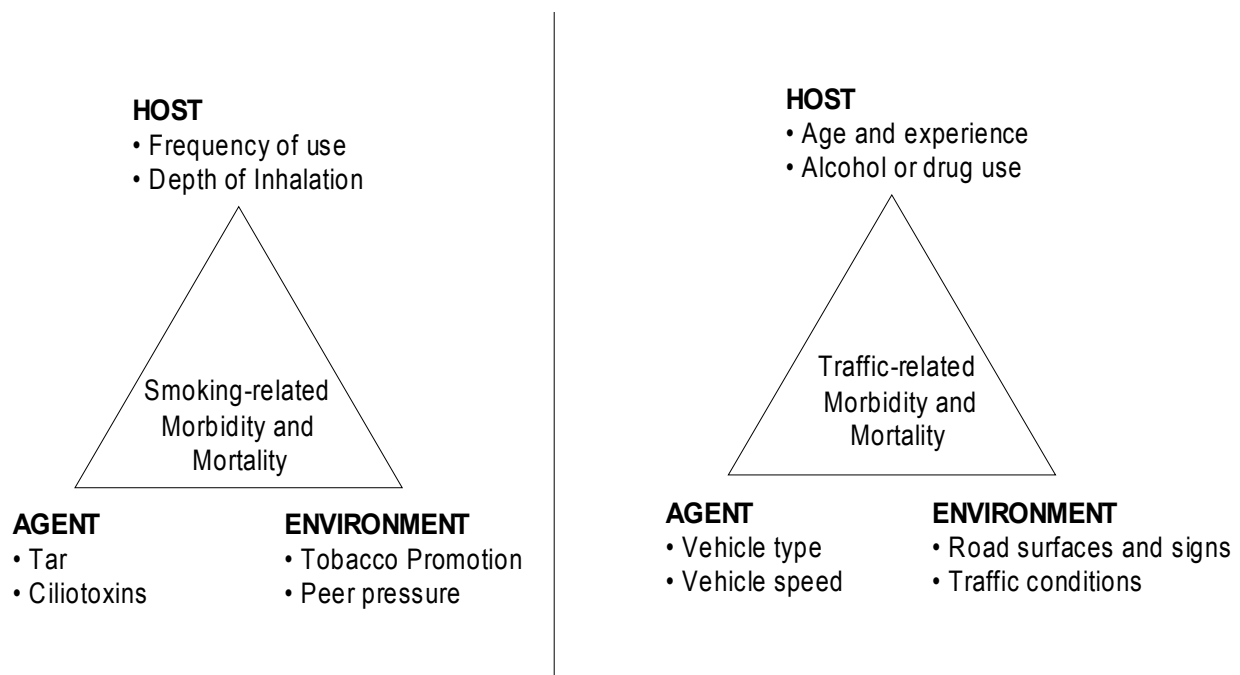
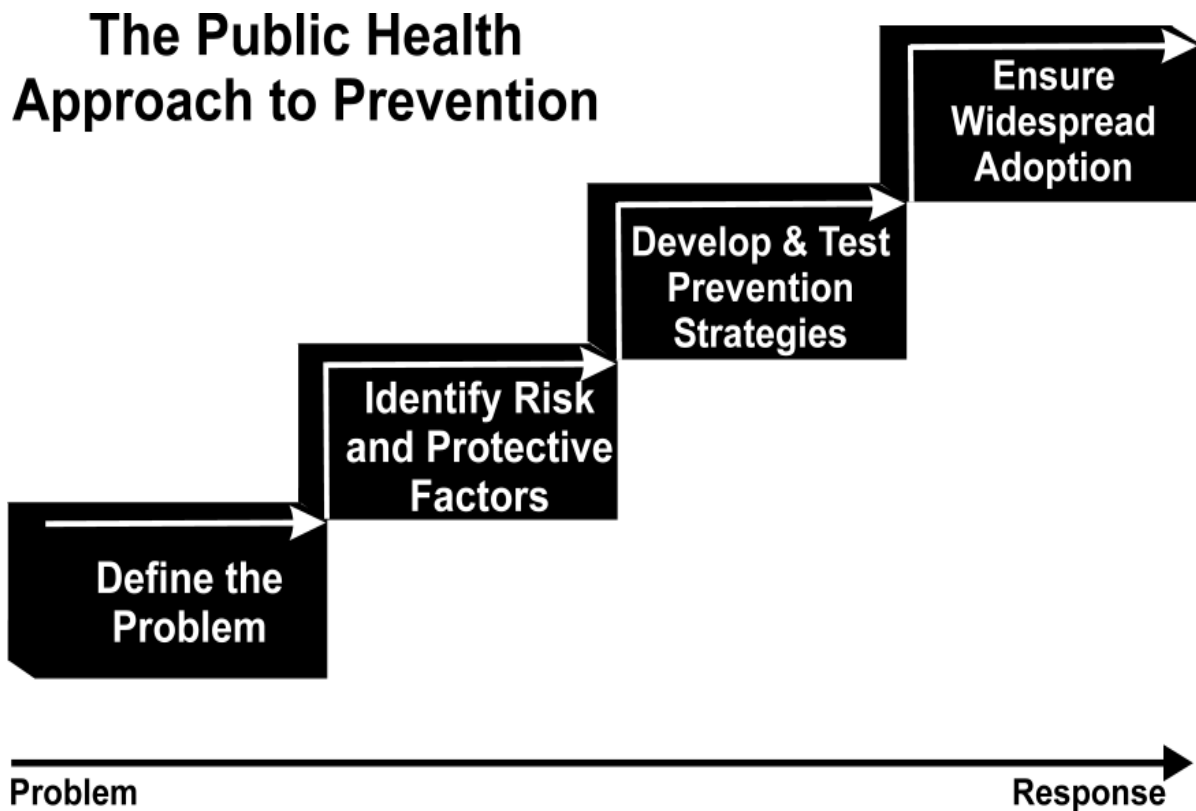


Figure 1: Interaction of factors in the epidemiologic triad related to smoking and traffic safety. From Sleet and Gielen (1998, figs 10.1 and 10.2).

The culture of safety at the Federal level got a boost when, in 1986, as a result of the National Academy of Sciences report titled *Injury in America* (Institute of Medicine 1985), Congress authorized funding to establish a national injury-prevention research program at the Centers for

Disease Control and Prevention (CDC). CDC brought this public health framework and epidemiologic perspective to motor vehicle injury prevention. The four-step model includes documenting the magnitude of the problem using surveillance; identifying risk and protective factors for crashes and injuries; developing and testing interventions to reduce the risk factors; and implementing and disseminating programs found to be effective (Figure 2). This model was directly applied to traffic safety programs with an emphasis on moving from initially defining the problem to responding with a preventive solution, in a sequential manner. CDC funded state and local health departments to conduct motor vehicle injury prevention programs using this model as a framework (Sleet, Bonzo, and Branche 1998). In addition, CDC funded “Centers of Excellence” to conduct injury control research, with the initial requirement that half of the money be spent on research related to motor vehicle injury prevention and control. Today, many of these centers continue to conduct important motor vehicle-related research with funding from CDC.



Centers for Disease Control and Prevention, National Center for Injury Prevention and Control

Figure 2: The public health approach to prevention.

State health departments, partly due to having carried out disease prevention and health promotion activities, have an important contribution to promoting a culture of safety. Resources to carry out that role, however, have been lacking. Most state funding for traffic safety programs has come from state offices of highway safety, funded by NHTSA, which provides a steady stream of safety funds based on the number of highway miles in the state. However, because of

their unique role in protecting and promoting the health of state and local populations, health departments should be key components in any effort to reduce traffic injuries. Health departments have the statutory responsibility for public health, provide community health services, deliver programs to underserved populations, and are typically experienced in working with a broad range of community groups and agencies (Sleet 1990). Preventing injuries related to motor vehicle crashes (e.g., alcohol-impaired driving, safety belt use, pedestrian and bicycle safety) is seen as an increasing responsibility of the health sector.

Other important contributors to the culture of safety have been the private sector, voluntary organizations, and non-profit groups like SafeKids Worldwide, and the Association for Safe International Road Travel (ASIRT). Advocacy groups like Mothers Against Drunk Driving (MADD), Physicians for Auto Safety, Advocates for Auto and Highway Safety, the Insurance Institute for Highway Safety, and the AAA Foundation for Traffic Safety have stimulated public debate, encouraged legislation and public policy, supported victim rights, and sponsored research. Such efforts, along with those of federal and state public health agencies and health and medical groups, have created a sea change in public interest and political action toward a culture of safety.

Collaboration within public health and medicine

In many respects the collaboration between traffic safety and public health about motor vehicle injury prevention stems from a common vision. Although the language and systems for addressing the problem may differ, both fields offer important and unique perspectives. Whereas each has influenced its own sector differently, the collective action has influenced the entire culture of safety.

Collaboration within the medical professions—particularly among physicians who treat crash victims—has contributed to the development of a culture of safety in large part because their collective views represent the voices of many thousands of their members. As early as 1950, both the American Medical Association and the American College of Surgeons had recommended that automobile manufacturers design cars for passenger safety and install them with safety belts. In 1961, the American Public Health Association in collaboration with the U.S. Public Health Service's Division of Accident Prevention, published *Accident Prevention: The Role of Physicians and Public Health Workers* (American Public Health Association 1961). At that time, the National Safety Council, the President's Committee for Traffic Safety, and the U.S. Public Health Service were all collaborating to reduce the unacceptable rise in traffic injury. Yet, Dr. Paul V. Joliet, then Chief of the Accident Prevention Program of the Public Health Service, cautioned his colleagues that "There are no simple easy solutions (to the traffic injury problem)" (FHWA 2006).

Ten years later, in what was called "an avant-garde medical text," Roberts (1971) published a 1,000 page book on *The Causes, Ecology and Prevention of Traffic Accidents*, thanks to contributions from leaders in the American Association for Automotive Medicine, Physicians for Automotive Safety, and the International Association for Accident and Traffic Medicine. More recently, professional associations, such as the American College of Preventive Medicine, the

American Trauma Society, the International Union for Health Education, the Society for Public Health Education, and the American Public Health Association, have adopted resolutions dedicating their leadership and professional members to promote highway and vehicle safety as a health issue and integrating traffic safety into their prevention efforts.

Today, collaboration abounds, particularly on the international front. The World Health Organization's *World Report on Road Traffic Injury Prevention* (Peden et al. 2004) and subsequent World Health Day in 2004 dedicated to "Road Safety is No Accident" helped engender an international climate for a culture of road safety with recommended actions to propel international unity around the problem. Also in 2004, after nearly 30 years of silence on the topic, the 57th World Health Assembly overwhelmingly adopted Resolution 57/10 on Road Safety and Health, calling for, among other actions, "multi-sector coordination" and collaboration. These collaborative efforts, over time, have fostered and will sustain efforts to build a culture of traffic safety within public health and medicine, reinforcing the perception that traffic safety and traffic injury prevention are (or should be) priority social and health goals in a civil society. Changes in traffic safety laws, public perceptions of vehicle safety, and enhanced enforcement have led toward cultural intolerance of reckless driving, drinking and driving, and non-use of safety belts, which have contributed to social norms favoring safety. It has taken a long time, but this collaboration demonstrates that with political will, cooperation from industry, social commitment, and public participation in the process, traffic injury prevention is achievable.

Progress toward the goal

Public Health's contribution to injury prevention has been multidisciplinary and directed toward collective action (Fisher 1988). Public health functions that have served the goals of motor vehicle injury prevention include assessment (monitoring health behaviors and identifying community health hazards), assurance (enforcing laws and regulations that protect people from injuries and linking people to needed prevention and trauma care), and healthy policy (developing policies and plans that support healthy environments and behaviors conducive to motor vehicle injury prevention). Although most of what public health accomplishes is in prevention, important advances also have been made in improving emergency medical services and developing, implementing, and evaluating comprehensive trauma care systems. By minimizing the consequences of an injury, these components of "tertiary" prevention are also characteristic of a culture of safety.

Since 1966, the combined efforts of government and private agencies and organizations to reduce motor vehicle fatalities have resulted in a 43% decrease in the rate of deaths per 100,000 population and a 72% decrease in deaths per vehicle miles traveled [VMT] (Figure 3). These reductions translate into more than 250,000 lives saved and countless injuries averted. (National Safety Council 2002). These gains are from changes in driver behavior, vehicle design, and road design that have improved both individual mobility and population safety. The reduction in U.S. motor vehicle death rates, especially in the wake of ever-increasing motorization, shifting demographics, and changing social patterns, is evidence of the growing culture of safety promulgated by both public health and traffic safety activities during the past four decades. In

fact, the CDC included motor vehicle safety as one of the 10 significant public health achievements of the 20th century (CDC 1999) and it is now considered one of the “silent victories” in the history and practice of public health in 20th century America (Dellinger, Sleet, and Jones 2007). Nonetheless, more work remains to be done, and future efforts must involve increasingly close collaboration among practitioners in traffic safety, public health, and medicine.

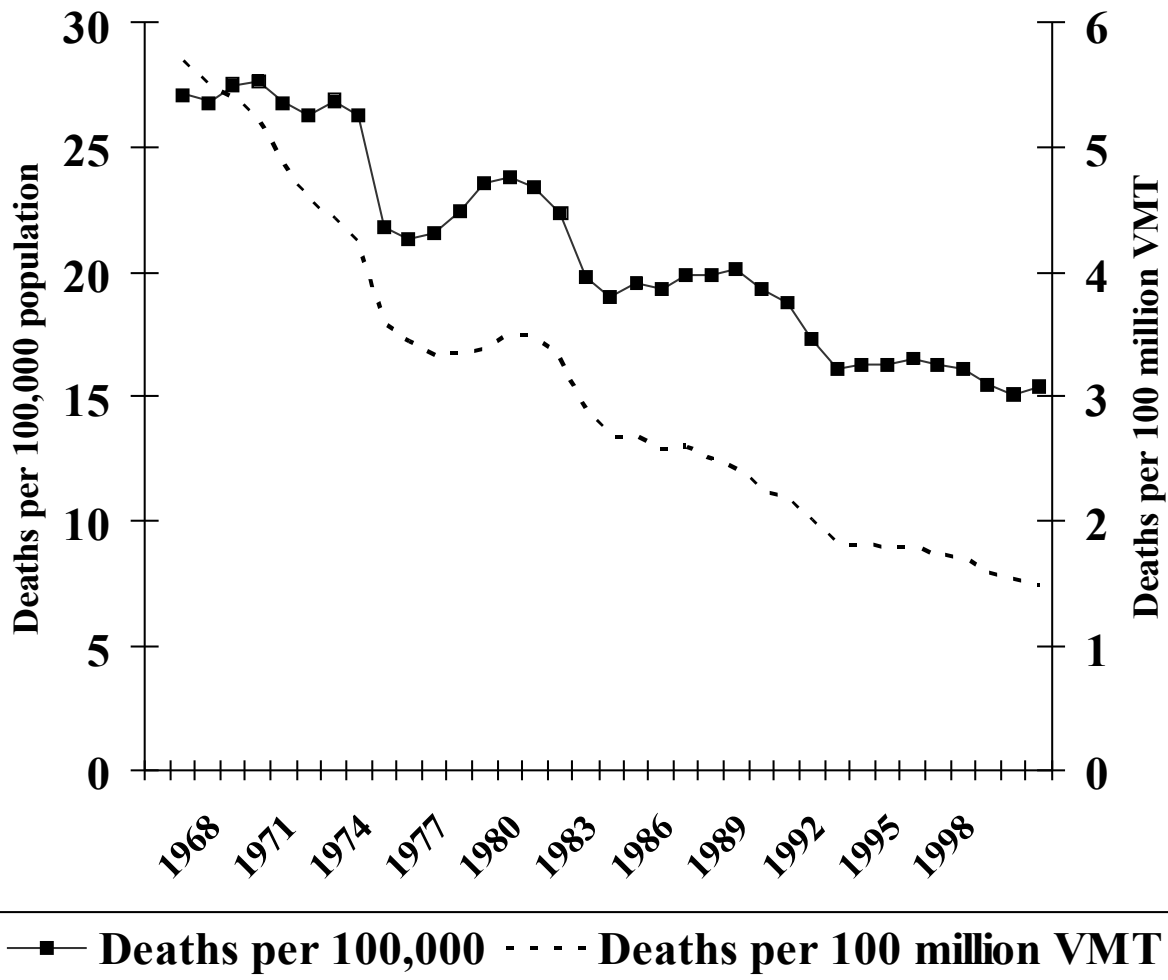


Figure 3. Motor vehicle death rates per 100,000 population and per 100 million vehicle miles traveled, 1966-2000—United States. Derived from National Safety Council data in *Injury Facts* (2002 edition), Itasca, IL.

Healthy People 2010

Adding to the significant milestones contributing to the culture of traffic safety are the directions set by the U.S. Department of Health and Human Services (DHHS) (2000) in its policy framework *Healthy People and Objectives for the Nation*. DHHS also developed another set of national goals: *Healthy People 2010*. Together, these goals aim to improve the country's health

by reducing preventable health threats. Public health professionals at local, state, and national levels work to meet and exceed these goals through public health interventions and policy changes.

In 1979, the U.S. Department of Health, Education, and Welfare (now the Department of Health and Human Services) identified motor vehicle trauma as a major public health problem (U.S. Department of Health, Education, and Welfare 1979) and developed specific health objectives for the nation to reduce the injury burden by 1990. These objectives were reviewed and expanded in 1990, and again in 2000, with a new set of motor vehicle–related goals and targets for the year 2010. *Healthy People 2010* includes specific objectives for decreasing motor vehicle and pedestrian-related deaths and injuries; increasing the use of safety belts, child restraints, and motorcycle and bicycle helmets; and implementing graduated driver licensing laws and bicycle-helmet legislation (see Table 1). Other objectives (not listed) specify goals to reduce non-fatal head trauma and spinal cord injury hospitalizations and to increase the use of alternative modes of transportation (U.S. Department of Health and Human Services 2000).

Table 1: Examples of Healthy People 2010 motor vehicle–related objectives. From U.S. Department of Health and Human Services (2000).

Number	Objective	1998 Baseline	2010 Target
15-15	Reduce deaths caused by motor vehicle crashes	15.6 deaths per 100,000 population 1.6 deaths per 100 million vehicle miles traveled	9.2 deaths per 100,000 population 0.8 deaths per 100 million vehicle miles traveled
15-16	Pedestrian deaths	1.9 pedestrian deaths per 100,000 population	1.0 pedestrian death per 100,000 population
15-17	Nonfatal motor vehicle injuries	1,181 nonfatal injuries per 100,000 population	933 nonfatal injuries per 100,000 population
15-18	Nonfatal pedestrian injuries	26 nonfatal pedestrian injuries per 100,000 population	19 nonfatal injuries per 100,000 population
15-19	Safety belts	69 % of total population	92%
15-20	Child restraints	92% of children 4 years and younger	100%
15-21	Motorcycle helmet use	67% of motorcycle operators and passengers	79%
15-22	Graduated driver licensing model law	23 states (in 1999)	All states and the District of Columbia
15-24	Bicycle helmet laws	10 states had laws requiring bicycle helmets for cyclists under age 15 years (in 1999)	All states and the District of Columbia

The CDC is the lead public health agency for establishing and tracking objectives related to injuries. The National Highway Traffic Safety Administration has been an essential partner in

these efforts by helping set targets and monitoring data about the motor vehicle injury problem since the inception of *Healthy People* in 1979.

Future challenges and opportunities

Despite substantial gains in motor vehicle injury prevention in the past 100 years, crashes and resultant injuries remain a major public health problem well into the 21st century. The possibilities for integrated research and cooperative programs of surveillance, intervention and evaluation between traffic safety and public health are almost limitless.

In the future, motor vehicle travel will contribute to a number of cross-cutting health problems—from personal safety to concerns over obesity and environmental pollution. These problems will be compounded as travel increases, populations grow, society ages, and reliance on cars increases. Most importantly, the costs and burdens associated with the more than 3,000 deaths, millions of injuries, and annual costs for care and rehabilitation, cannot be sustained by society for much longer.

Conflict has always existed between the goals of mobility and the goals of safety and this balance must be continually re-evaluated. For example, although the national 55 mph speed limit was instituted to conserve fuel, it also resulted in fewer crashes and fewer crash deaths. When fuel availability increased, so did speeds and road deaths. This illustrates the trade-off between one aspect of mobility (speed) and traffic safety. Evidently, the public was not willing to maintain restricted mobility despite the substantial safety benefits. By strengthening a culture of safety, this viewpoint can be changed to embrace safety.

Additionally, new conflicts are emerging between “automobility” and the goals of traffic safety and public health. For example, parents are encouraged to increase physical activity for children by promoting walking, but because of traffic safety or security concerns, they may be reluctant to allow their children to walk near traffic, even short distances. Adults themselves may struggle with the choice of walking or cycling instead of driving to work. Fuel-efficient cars may be better for the environment and contribute less to conditions such as asthma, which achieves one public health goal, but driving a fuel-efficient car does not reduce the risk of cardiovascular disease or promote health and fitness, which is another public health goal (Kelter 2006). Such conflicts will present unique challenges that must be addressed thoughtfully and from a broad perspective as we move forward toward an integrated safety culture.

As new technologies are incorporated into vehicles, drivers will face new behavioral and attention demands (Waller 2001; Porter and Bliss 2006). Distractions such as cell phones, in-vehicle entertainment systems, and vehicle-equipped Internet and global positioning systems pose problems that could undermine a culture of safety. Rises in traffic volume and congestion can be expected, along with changes in the ratio of small vs. large vehicles. Computerized in-vehicle early-warning systems to detect an imminent crash also present new safety challenges that will require innovative solutions. Safety gains derived from making cars safer, reducing alcohol-impaired driving and speeding, and increasing safety belt use may be offset by new

hazards related to driver distraction, fatigue, or sensory overload. The cry for more efficient mobility will have to be tempered with the need for more safety as the culture of technology (gadgets) begins to overtake the culture of safety.

Special populations will continue to be a focus of research. Interventions to reduce alcoholism and problem drinking at the population level should continue, as should targeting “binge” drinking and hard-core drinking drivers. These efforts will benefit traffic safety. Teen driving risks will continue to be a problem, as cohorts of new inexperienced drivers are added to the driving mix. Research on the effectiveness of graduated drivers licensing programs will remain important, as will improvements in driver education and training. Because neuroscience continually reveals new information about the adolescent brain, the cognitive aspects of adolescent driving will play an increasingly important role in research.

As the population ages, crash and injury prevention; among older drivers will become a higher priority. Adults over age 65 are expected to double by the year 2030 (U.S. Census Bureau 2003). Because people are living longer, older persons will be driving longer, increasing their exposure to crashes and injuries. Assisting older adults in successfully balancing safety and mobility will be an important challenge and will involve commitment from health, social services agencies, and traffic safety agencies and advocates. Changes to consider involve the vehicle (e.g., safety belts that are easier to reach, visual displays that are easier to read, pedals that are easier to reach and depress); the roadway (e.g., signs that are easier to read, junctions that are easier to navigate); and driver behavior (e.g., improved functional screenings and assessments of older adults to identify those who should be monitored or stop driving). The availability of practical alternative transportation options for older adults should be a high priority as their needs for greater mobility expand with increased longevity.

Immigration will also bring new challenges to traffic safety, as transplanted drivers and pedestrians carry with them their own cultural patterns of walking and driving. Many of these may be incompatible with a culture of safety. Traffic safety and public health will need to work together to determine how population changes will impact traffic safety and the health of future generations and to assure diverse populations stay safe while mobile.

With so many challenges facing traffic safety and injury control, a comprehensive approach is vital. Our whole culture of safety must be improved, rather than simply addressing individual traffic safety issues as they arise. There remains a critical need to support training for new researchers and practitioners in safety culture and to broaden the public health implications of the traffic safety problem (Waller 2001).

How public health can create a culture of safety

The greatest successes in public health have resulted from cultural change (Ward and Warren 2007). For example, smoking was once considered harmless and part of a healthy and active lifestyle. In the 1930s, cigarette advertisements in the United States often showcased physicians

and athletes as spokespersons. With mounting scientific evidence on the hazards of smoking and a shift from emphasizing dangers to the smoker to dangers to the non-smoker, the public began viewing smoking negatively and health culture was permanently changed. Likewise, creating a safety culture will require a shift in how we think about traffic hazards, personal risk behaviors, and the value of prevention. Public health can contribute to this shift by:

- Including road safety in health promotion and disease prevention activities.
- Incorporating safety culture into health education activities for adolescents so that they associate safety with all aspects of life.
- Requiring safety impact assessments similar to environmental impact assessments (i.e., before new roads are built).
- Using public health tools to help the transportation sector in conducting safety audits to identify unsafe roads and intersections.
- Incorporating safety and mobility into healthy aging—for example, by focusing on the mobility needs of older adults, especially as they relinquish their driving privileges.
- Applying modern evaluation techniques to measure the impact of road safety programs and injury prevention interventions.
- Measuring health care costs and public health consequences of traffic injuries.
- Assisting states and communities with local injury data collection and traffic-injury surveillance systems.
- Reducing health disparities by assuring equal access to community preventive services such as child safety seats, bicycle helmets, and neighborhood sidewalks for poor or underserved populations.
- Strengthening pre-hospital and hospital care for trauma victims by supporting comprehensive trauma care systems, nationwide.

Public health cannot do this alone. Other sectors in society must be encouraged to participate (i.e., education, transportation, business, economics, justice, and social services). Using a multidisciplinary perspective, traffic safety and health can move into urban planning, the built environment, social ecology, road administration, injury surveillance, and social marketing as necessary extensions of their work to preserve health and safety.

Comprehensive, integrated public health surveillance systems will be needed that can provide policy makers, planners, and public health officials at the state and local levels with timely data on crashes, injuries, and deaths. This will enable them to set realistic priorities and implement prevention strategies in the midst of other competing priorities (Holder, Peden, Krug, et al. 2001; Thacker et al. 1996; Espitia-Hardeman and Paulozzi 2005).

On the intervention side, we know that because the conditions that give rise to motor vehicle injuries are complex with multiple and interrelated causes; therefore, interventions will have to be comprehensive and tailored (Dellinger et al. 2007). Prevention efforts in most areas of public health benefit from an approach that relies on the combination of multiple interventions. Health

promotion provides a useful framework for accomplishing this because it relies on a combination of approaches (Sleet 1984, 1989; Lonero et al. 2006). Interventions considered part of the health promotion approach include: economic interventions, organizational interventions, policy interventions, environmental supports, and health education interventions, including the use of media, school and community education and public awareness programs (Howat, Sleet, Elder, et al. 2004). Integrating health promotion approaches so successfully used for tobacco control and chronic disease prevention into motor vehicle injury prevention is likely to advance efforts to build a culture of safety on the highway, at school, in the home, at work, in the doctor's office, and in the community.

One of the remaining obstacles is the public's misconception that injuries are accidents that occur by chance. It has been difficult to summon popular sentiment for motor vehicle injury because there is no single cause or cure, it is not widely recognized as a public health problem, and most people consider injury the result of an uncontrollable "accident." For many, road trauma is simply the price we pay for mobility. Whereas some progress has been made toward changing public perception about the predictability of injury and its preventable nature, more must be done. Public health professionals have been successful in framing motor vehicle injuries in the context of other preventable causes of death and disease. The medical professions have been quick to recognize their role as advocates for motor vehicle safety with patients and policy makers and the importance of emphasizing lifestyle changes that include safety behaviors. By framing motor vehicle injury as predictable and preventable health practitioners will have a tool to educate the public and influence policy makers about a serious public health problem that can be reduced, just like many diseases. A culture of safety that provides for safe and accessible transportation can prevent injury and death and improve the overall quality of life for populations. Put in the context of national health objectives, by improving traffic safety we also improve public health.

Disclaimer

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References

- American Public Health Association. 1961. *Accident prevention: The role of physicians and public health workers*. New York: McGraw-Hill Book Company, Inc., pp. 127.
- Association of Schools of Public Health. 2006. *What is public health?* Available online at <http://www.asph.org>. (accessed August 18, 2006).
- Blincoe, L. J., A. G. Seay, E. Zaloshnja, T. R. Miller, E. O. Romano, S. Luchter, and R. S. Spicer. 2002. *The economic impact of motor vehicle crashes 2000*. National Highway Traffic Safety Administration, US Department of Transportation, Report No. DOT HS 809 446, May 2002.
- Centers for Disease Control and Prevention (CDC). 1999. Motor vehicle safety: A 20th century public health achievement. *MMWR* 48 (18): 369–74.
- Dellinger, A., D. A. Sleet, and B. H. Jones. 2007. Drivers, wheels, and roads: Motor vehicle safety in the twentieth century. In J. Ward and C. Warren, eds. *Silent victories: The history and practice of public health in twentieth-century America*. New York: Oxford University Press.
- Dellinger, A., D. A. Sleet, R. Shults, and C. Rinehart. 2007. Preventing motor vehicle-related injuries. Chapter 10. In L. Doll, S. Bonzo, J. Mercy, and D. Sleet, eds. *Handbook of injury and violence prevention*. New York: Springer.
- Department of Health and Human Services, Public Health Service. 1992. Position papers from the *Third national injury control conference: Setting the national agenda for injury control in the 1990's*. Washington, DC: Government Printing Office, DHHS Pub. No. 1992-634–66.
- Espitia-Hardeman, V., and L. Paulozzi. 2005 *Injury surveillance training manual*. National Center for Injury Prevention and Control. Centers for Disease Control and Prevention, Atlanta GA.
- Evans, L. 1991. *Traffic safety and the driver*. New York: Van Nostrand Reinhold.
- Federal Highway Administration. 2003. *Manual on uniform traffic control devices for streets and highways*. Washington, DC: US Department of Transportation (in accordance with Title 23 US Code, Sections 109(d), 114(a), 217, 315, and 402(a), 23 CFR 655, and 49 CFR 1.48(b)(33) and 1.48(c)(2).
- . 2006. *President Dwight D. Eisenhower and the federal role in highway safety*. (Chapter 3: Maintaining the focus). From www.fhwa.dot.gov/infrastructure/safety03.htm (accessed September 3, 2006).
- Finklestein, E., P. S. Corso, and T. R. Miller. 2006. *The incidence and economic burden of injuries in the United States*. New York: Oxford University Press.
- Fisher, L. 1988. Childhood injuries—causes, preventive theories and case studies: An overview on the role for sanitarians and other health professionals. *Journal of Environmental Health* 50 (6): 355–60.
- Global Traffic Safety Trust. 1998. *Reflections on the transfer of traffic safety knowledge to motorizing nations*. Melbourne, Australia: Global Traffic Safety Trust.

- Gordon, J. E. 1949. The epidemiology of accidents. *Am J Public Health* 39:504–15.
- Haddon, W. 1968. The changing approach to the epidemiology, prevention, and amelioration of trauma: The transition to approaches epidemiologically rather than descriptively based. *Am J Public Health* 58:1431–8.
- Holder, Y., M. Peden, E. Krug, et al., eds. 2001. *Injury surveillance guidelines*. Geneva, World Health Organization.
- Howat, P., D. A. Sleet, R. Elder, and B. Maycock. 2004. Preventing alcohol-related traffic injury: A health promotion approach. *Traffic Injury Prevention* 5:208–19.
- Institute of Medicine (IOM). 1985. *Injury in America: A continuing public health problem*. Washington, DC: National Research Council, Institute of Medicine, National Academy Press.
- . 1999. *Reducing the burden of injury: Advancing prevention and treatment*. Washington DC: Committee on Injury Prevention and Control, Division of Health Promotion and Disease Prevention. National Academy Press.
- Kelter, Alexander. 2006. *Think medically, act socially*. Presentation at New Partners for Smart Growth 5th Annual Conference, Denver, Colorado, January 26, 2006.
- Lonero, L., K. Clinton, and D. A. Sleet. 2006. Behavior change interventions in road safety. Chapter 10. In A. C. Gielen, D. A. Sleet, and R. DiClemente, eds. *Injury and violence prevention: Behavior change theories, methods and applications*. San Francisco, CA: Jossey-Bass, pp. 213–33.
- National Highway Traffic Safety Administration (NHTSA). 2006. *Motor vehicle traffic crash fatality counts and estimates of people injured for 2005*. DOT HS 810 639, August 2006.
- National Safety Council (NSC). 2002. *Injury facts, 2002 edition*. Itasca, Illinois: National Safety Council.
- National SAFE KIDS Campaign. Washington, DC. As quoted from www.blythedale.org/health/safe_kids.asp (accessed September, 2006).
- Network of Employers for Traffic Safety. Quoted from www.trafficsafety.org/cost_of_crashes.asp (accessed October 1, 2006).
- Peden, M., R. Scurfield, D. Sleet, D. Mohan, A. A. Hyder, E. Jarawan, and C. Mathers. 2004. *World report on road traffic injury prevention*. Geneva, World Health Organization.
- Porter, B. E., and J. P. Bliss. 2007. Human Factors in Product and Environmental Design for Injury Control. In A. C. Gielen, D. A. Sleet, and R. DiClemente, eds. *Injury and violence prevention: Behavior change theories, methods and applications*. San Francisco, CA: Jossey-Bass, pp. 467–84.
- Rice, D. P., E. J. MacKenzie, A. S. Jones, et al. 1989. *Cost of injury in the United States: A report to Congress*. San Francisco, CA: University of California, Institute for Health and Aging; Johns Hopkins University, Injury Prevention Center.
- Roberts, H. J. 1971. *The causes, ecology and prevention of traffic accidents*. Springfield: Illinois, Charles C Thomas Publisher.

- Roosevelt, F. D. 1935. A plea for state cooperation to reduce automobile accidents. January 24, 1935. In *Roosevelt, Franklin D. Public Papers and Addresses of Franklin D. Roosevelt*, vol 4, pp. 62–63. New York: Random House, 1938. (Courtesy of Franklin D. Roosevelt Library, Hyde Park, New York).
- Shinar, D. 1978. *Psychology on the road*. New York: John Wiley & Sons.
- Sleet, D. A., B. Dinh-Zarr, and A. Dellinger. 2007. Traffic safety in the context of health and medicine. In *Improving traffic safety culture in the U.S.: The journey forward*. Washington, DC: AAA Foundation for Traffic Safety.
- Sleet, D. A., ed. 1984. Occupant protection and health promotion. *Health Education Quarterly*, vol. 11, no. 2.
- . 1987. Motor vehicle trauma and safety belt use in the context of public health priorities. *J Trauma* 27 (7): 695–702.
- . 1989. Drinking, driving and health promotion. *Health Education Quarterly* 16 (3) Fall.
- . 1990. *Reducing traffic injuries in America: U.S. objectives and strategies*. Proceedings of Inaugural Conference of Roadwatch. Perth, Australia: Road Accident Prevention Research Unit, University of Western Australia, Perth, 31–46.
- Sleet, D. A., S. Bonzo, and C. Branche. 1998. An overview of the national center for injury prevention and control at the centers for disease control and prevention. *Injury Prev* 4 (4): 308–12.
- Sleet, D. A., and A. Gielen. 1998. Injury prevention. In J. Arnold and S. Gorin, eds. *Health Promotion Handbook*. Mosby, St Louis, MO, pp. 247–75.
- Thacker, S. B., D. F. Stroup, R. G. Parrish, and H. A. Anderson. 1996. Surveillance in environmental public health: Issues, systems, and sources. *Am J Public Health* 86:633–8.
- Transportation Research Board (TRB). 1990. *Safety research for a changing highway environment*. Washington, DC: National Research Council, Transportation Research Board, Special Report 229.
- U.S. Department of Health and Human Services. 2000. *Healthy People 2010*. 2nd ed. (with understanding and improving health and objectives for improved health). 2 vols. Washington, DC, Government Printing Office.
- US Census Bureau. 2003. *Population projections program*. Population Division. Washington, DC: Bureau of the Census. available from: URL: www.census.gov/population/projections/nation/summary (accessed September 2003).
- U.S. Department of Health, Education and Welfare. 1979. *Healthy People: The Surgeon General's report on health promotion and disease prevention*. DHEW (PHS) Publication No. 79-55071, U.S. Government Printing Office.
- Waller, J. 1985. *Injury control: A guide to causes and prevention of trauma*. Lexington, KY: D.C. Heath & Co.

Waller, P. F. 2001. Public health's contribution to motor vehicle injury prevention. *Am J Prev Med* 2001 21 (4S): 3–4.

Ward, J. W., and C. Warren, eds. 2007. *Silent victories: The history and practice of public health in twentieth-century America*. New York: Oxford University Press.

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