Transportation and Health:
Policy Interventions for Safer, Healthier People and Communities




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Safe Transportation Research & Education Center
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Acknowledgements

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This publication was made possible by cooperative agreement 3U58HM000216-05W1 between the Centers for Disease Control and Prevention and Partnership for Prevention and through contracts with Booz Allen Hamilton and the Safe Transportation Research and Education Center (SafeTREC) at UC Berkeley.

Disclaimer

The contents of this report are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention.

July 2011

Foreword

Public health researchers, practitioners and advocates recognize that policies from many fields can significantly affect health. Policies about the crops we grow, the parks we build, and the roads we travel have widespread impact on our health and wellness. No longer can we afford to narrowly consider which policy issues are examined with respect to health, and which stakeholders' voices are heard. Public policies are most effective when all meaningful science and data are analyzed and implications and outcomes are discussed from a variety of perspectives. We know that vehicle emissions are related to higher incidences of respiratory disease, cardiovascular disease, and adverse pregnancy outcomes. We know that community design and walking and biking accessibility affect physical activity levels and heart health. And we know that seat belts save lives.

Partnership for Prevention seeks to support the development of transportation policies that also promote the nation's health. We are pleased to have collaborated with the Safe Transportation Research and Education Center (SafeTREC) at UC Berkeley, Booz Allen Hamilton, and the Centers for Disease Control and Prevention to produce this report examining the effects of transportation policies on public health in three key areas—environment and environmental public health, community design and active transportation, and motor vehicle-related injuries and fatalities.

Our analyses show that many of the policies in this document can have immediate, mid-term, or long-term effects. Installing streetlights, new sidewalks, and bicycle-friendly infrastructure can have positive effects that are felt immediately. Incorporating bicycle boulevards or greenways into comprehensive community plans will likely bring about changes over time. The health effects of these policies will also play out in different time frames.

In order for transportation policy to positively affect health, expanded education and relationship building with multiple stakeholders at various levels is necessary. National, state, and local collaborations that bring together health policy leaders, the business community, government officials, and educators are steps in the right direction. Partnership for Prevention, a nonpartisan, national organization of business, non-profit and government leaders, seeks to create a "prevention culture" in America, where disease prevention and health promotion, based on the best scientific evidence, are high priorities for policy makers, business leaders, and practitioners. We encourage all organizations and individuals promoting health-focused transportation policies to urge policy makers to adopt policies consistent with the evidence-based recommendations presented in this document.

Jud Richland, President
Partnership for Prevention

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Preface

During the decades after World War II, U.S. surface transportation policy was concerned primarily with the road system and the vehicles that travel on it. An enormous increase in motor vehicle ownership and use took place—to the point where, in 2007, more than 3 trillion miles were traveled in motor vehicles.

There were positive outcomes associated with this growth: increased mobility and access to jobs, education, health care, and recreation. There were other consequences, too. These include an increase in traffic collisions and associated injury, death, and costs, a substantial reduction in physical activity, and an increase in emissions harmful to public health and the environment. Additionally, a lack of efficient alternatives to automobiles for transportation disproportionately affects vulnerable populations such as the poor, the elderly, people who have disabilities, and youth by limiting access to jobs, health care, social interaction, and healthy foods.

Steps have been taken to address many of these consequences. Public transit, walking, and bicycling have all seen an increased emphasis in recent years, and government support for these modes has grown substantially in absolute dollars. There is growing awareness in communities that land use decisions and development patterns influence the transportation choices that are available to residents, and that such choices have health impacts. In the past several decades, legislation such as the Clean Air Act has reduced harmful motor vehicle emissions; programs like Safe Routes to School have encouraged active transportation (i.e., walking and bicycling) with resulting improvements in health; and seatbelt and other enforcement programs, along with improved vehicle safety standards, have cut highway deaths and injuries and their associated costs.

Most of these transportation policies and programs promoting public health also have the co-benefit of reducing energy use by substituting lower-energy modes for high-energy modes and promoting more efficient use of energy through improvements in fuel efficiency and congestion management.

Promoting health and reducing health care costs are urgent national goals—goals that can be achieved, in part, through our nation's transportation policies. In this review we highlight existing scientific evidence on the health effects of transportation policy and provide credible information that is useful to decision makers at the federal, state, and local level. Stakeholders including public health professionals and the general public will also find the document to be useful. The work presented here is not exhaustive of all transportation policy areas that impact public health and safety, but contributes to a growing body of resources that can inform evidence-based policy making.

Executive Summary

Introduction

The public road system in the U.S. is the world's busiest, sustaining more than 3 trillion vehicle-miles of travel each year on a network of more than 4 million miles of roads and highways. It has had enormous positive impacts on U.S. society, driving economic growth and innovation, providing mobility and opportunity to its users, and helping the U.S. maintain its global economic competitiveness.

This system was built with a focus on motor vehicles; only recently has substantial funding and attention been given to transit, walking, and bicycling. There is still a huge disparity in how we travel: between 1990 and 2009 the yearly vehicle-miles traveled for passenger cars and light-duty trucks increased by 39 percent; yearly motor fuel consumption rose 27 percent, to 168 billion gallons. And for those unable or unwilling to purchase and use a private automobile for transportation, there can be disparate access to economic opportunity, services, and social interaction.

Enhancing multimodal surface transportation will provide more options for travel and at the same time advance important public health goals. Doing so will expand beyond immediate goals such as investing in infrastructure, developing more sustainable transportation systems, and supporting economic recovery. Doing so will enable more distal, but equally worthy outcomes including: improving people's health and well-being and reducing health care costs; increasing physical activity; and improving air quality and reducing consumption of fossil fuels and unwanted emissions, including those that contribute to climate change.

Both the general public and the government have a strong interest in improving health, bringing down health care costs, and reducing energy use and traffic congestion. The report is divided into three chapters to focus on the following policy areas: policies that improve the environment and environmental health (Chapter 1); policies that enhance community design and promote active transportation (Chapter 2); and policies that reduce motor vehicle-related injuries and fatalities (Chapter 3).

Policies That Improve the Environment and Environmental Public Health (Chapter 1)

Chapter 1 presents policies that would reduce the transportation system's impacts on the environment and environmental public health, chiefly through reducing the ill effects of

transportation-related emissions. This can be done through two approaches: reducing the amount of emissions that are generated, and reducing exposure to these emissions when they do occur.

Tailpipe emissions, which are the by-products of fuel combustion, and emissions from electricity-generating sources (in the case of electric-powered vehicles) have a direct impact on the environment and human health. Their health effects are well-documented—higher incidences of: respiratory disease (such as asthma and chronic obstructive pulmonary disease), cardiovascular disease, and adverse pregnancy outcomes. Pregnant women, children, and the elderly are the most vulnerable. Yearly costs of treating related diseases and those incurred by premature deaths associated with exposure to these emissions are high, as are the costs of the associated losses in productivity. On the larger-scale level of environmental health, one of the largest impacts from transportation-related emissions is the generation of greenhouse gases—carbon dioxide, primarily—which are associated with climate change.

Reduce Human Exposure to Transportation-Related Emissions

Tighter emissions and fuel efficiency standards have reduced vehicle emissions, but their impact has been lessened by the rise in the number of vehicle-miles traveled (VMT).

Improving air quality monitoring systems to give individuals and communities the information they need to make healthier choices; separating high-polluting facilities from vulnerable populations; and further reductions in tailpipe emissions and improvements in fuel efficiency will all go far in reducing human exposure to transportation-related emissions.

Reduce the Transportation System's Contribution to Climate Change

Transportation is responsible for one-third of the country's carbon dioxide emissions, of which 64 percent is generated by passenger cars and light-duty trucks.

Changing the makeup of our vehicle fleet so that it relies less on high-carbon power and has a greater share of vehicles that are physically smaller will decrease transportation's contribution to climate change.

Promote a Reduction in Vehicle-Miles Traveled Through Pricing Measures

The overwhelming number of vehicle miles traveled (VMT) in the U.S are made in motor vehicles—some 3 trillion miles in 2007. In 2009, 83 percent of all trips made by the American public were in private vehicles.

Providing incentives to encourage changes in travel behavior, including adopting new behavior such as walking and bicycling, will help replace some motor vehicle trips with transit, walking, or bicycling, or by combining trips or changing the time when they are made. Any of these actions will help reduce VMT.

Policies That Enhance Community Design and Promote Active Transportation (Chapter 2)

Chapter 2 explores policies that can enhance community design in order to promote safe and active transportation. As outlined below, these policies can lead to changes in the shape and nature of our communities, so that active transportation can become a more attractive and viable option for all Americans.

Provide Better Connectivity for Pedestrians and Bicyclists

Land use and development patterns have created community environments in which many Americans never walk to destinations and have come to depend on motor vehicle travel. More than one-third of Americans reported having taken no walking trips in the previous week, in part because destinations are so spread out, or routes are not safe or welcoming.

Adopting where possible smaller block sizes, encouraging the appropriate location of key community destinations, and employing land use patterns that make cities more connected for bicyclists and pedestrians will make active transportation more practical and attractive.

Increase Investments in Infrastructure that Supports Active Transportation

The built environment has a demonstrated effect on whether people choose to walk or take transit or bicycle rather than drive. Only in recent years has federal transportation policy made a concerted investment in infrastructure that makes non-motorized, active transportation easier. This includes: sidewalks, multi-use trails, bicycle lanes and paths, bicycle boulevards, medians, crosswalks, signs, and street designs that narrow roadways and reduce traffic speed.

Existing programs such as Safe Routes to Schools and policy concepts such as Complete Streets support active transportation along with new approaches such as bicycle boulevards, pedestrian- and bicycle-oriented wayfinding, and facility design.

Consider the Needs of All Road Users in Planning and Design Standards

Transportation policy has historically placed the highest priority on achieving efficiencies for motor vehicles. This emphasis has had negative effects on pedestrian and bicycle safety and, by extension, the amount of active travel that the transportation system can support.

By developing standards for incorporating the needs of pedestrians and bicyclists in all transportation projects, pedestrians and bicyclists will be afforded greater safety. This means adopting new approaches to levels of service, incorporating pedestrian and bicycle experience of the transportation system as a measure of success, and encouraging pedestrian- and bicycle-friendly vehicle designs.

Make Public Transit Easier to Use for Pedestrians and Bicyclists

Public transit enables personal mobility for all people. There is enormous potential in the role that public transit can play in amplifying the practicality of walking and bicycling trips. Conversely, adequate connections between transit and pedestrian and bicycle facilities can go far in solving the "first/last mile" problem that hinders transit's usefulness.

Opportunities to achieve this goal include making transit stops and stations more accessible by foot and bicycle, making ample room for bicycles on trains and buses, providing route maps and schedule information, and policies to encourage development in and around transit stops and stations—transit-oriented development.

Policies That Reduce Motor Vehicle-Related Injuries and Fatalities (Chapter 3)

Chapter 3 explores ways to make motor vehicle operation safer. Over the past few decades, the rate of traffic fatalities and injuries has dropped significantly. The successes in increasing seat belt use and reducing driving under the influence (DUI) are among the most significant achievements in U.S. public health history.

Nevertheless, the potential exists for even more substantial reductions in traffic deaths, injuries, and associated costs. Policy issues with particular promise are reducing DUI, distracted driving, driving beyond skill or experience levels, speeding, and enhancing seat belt and child passenger protection use.

Reduce the Incidence of Driving under the Influence (DUI)

Major enforcement and education efforts resulted in a significant drop in DUI crashes starting in the 1980s and continuing through the 1990s. After leveling off for a few years, the percentage dropped in 2005, reaching a new low. However, in 2009, DUI deaths still numbered approximately 11,000.

DUI enforcement is a public health success story that can be built upon by extending the use of ignition interlocks to prevent DUI repeat offenses, increasing the use of and training in sobriety checkpoints, maintaining the national minimum drinking age at 21, and strengthening zero-tolerance laws for young drivers.

Decrease Distracted Driving

The rise in the use of cell phones and other electronic devices while driving has created a new form of distracted driving. With the proliferation of vehicle-based electronic distractions, the problem promises to become larger.

Countermeasures for reducing these distractions are in the early stages of development. However, based on successful policies in preventing DUI and increasing seat belt use, providing incentives for states to pass cell phone and electronic device laws and providing funds for enforcement and education may help reduce distracted driving crashes.

Reduce the Incidence of Younger Drivers Driving Beyond Their Skills

Motor vehicle crashes are the leading cause of death for adolescents in the U.S. The crash rate per mile driven for 16- to 19-year-olds is four times that of older drivers. Strong graduated driver licensing (GDL) programs for new drivers are highly effective in reducing their crash risk. While all states have GDL programs in place, increased benefits can be achieved by ensuring compliance and testing.

Reduce the Incidence of Older Drivers Driving Beyond Their Cognitive and Physical Abilities

The number of older (age 65 and over) licensed drivers increased 23 percent between 1999 and 2009. Drivers age 70 and older have elevated risk of being at fault for fatal crashes. In addition, older adults have an increased susceptibility to injury and medical complications when involved in a crash. For older drivers, the use of license evaluation for identifying perceptual or cognitive deficits reduces crashes.

Reduce the Incidence of Speeding

Speeding contributes to nearly one-third of fatal crashes, and speeding is very common. Under extreme weather-related road conditions, such as snow, slush, and ice, speeding is even more dangerous. Pedestrians and bicyclists are at particular risk in speed-related crashes because they do not enjoy the protection of a vehicle.

The use of automated speed enforcement cameras in concert with proven traditional methods and engineering changes can reduce the incidence of speeding and speed-related crashes. Changing road designs to slow traffic reduces the danger faced by pedestrians and bicyclists.

Increase Seat Belt Use

Seat belt use is proven to save lives, and seat belt use has risen in the U.S. However, year-to-year increases in seat belt use are small, with some regions reporting 25 percent of vehicle occupants unbelted.

Proven policies to increase seat belt use include primary seat belt laws and federal support for enhanced enforcement programs, which have been developed by a number of states.

Increase Use of Age- and Size-Appropriate Child Safety Seats and Booster Seats

When used correctly, child safety seats are remarkably effective at preventing death and injuries. However, their use is still inconsistent, with confusing guidelines and a variety of designs and options.

The National Highway Traffic Safety Administration (NHTSA) has developed age-based standards for use of child restraints. Incentives to states to adopt them, along with incentives for standards in child restraint designs would, along with increased funding for education and enforcement, help reduce deaths and injuries among child passengers.

Intended Audiences

Information in this report has been compiled to understand the currently available information on the health effects of transportation policies, and to assist policy makers in identifying appropriate policy solutions. It will also inform other stakeholders, including the general public.

Multiple Levels of Transportation Decision-Making in the U.S.

The U.S. Congress has a major impact through the surface transportation bill, which funds programs through the U.S. Department of Transportation (U.S. DOT), and also through legislation governing the Environmental Protection Agency (EPA) and the Centers for Disease Control and Prevention (CDC).

Federal mechanisms for influencing the transportation system include direct requirements tied to funding and various formulas for distributing Highway Trust Fund dollars, incentive grants to influence laws and regulations at the state and regional level, and regulations that set national standards.

State agencies include state departments of transportation, law enforcement agencies, and departments of motor vehicles (DMVs). Regional agencies include metropolitan planning organizations (MPOs) and enforcement agencies. City and county governments play a role in local decision-making. Finally, there are large numbers of advocacy organizations and groups that work to influence decisions related to their issues or constituencies.

Study Methodology

This report is based on a review of existing literature, generally from within the last 10 years, and drawn from a universe of sources that fall within these bounds: government agency reports and statistical sources, peer-reviewed academic journals accessed through searches of the two authoritative online bibliographic databases relevant to this study—Medline/PubMed and

the Transport Research International Documentation (TRID) database of the Transportation Research Board of the National Academies of Science.

Emerging Research Opportunities

The body of current research has yielded conclusions about impacts of transportation on health, and the policies and practices to mitigate such impacts. Our review has also revealed areas for additional research that could add to the body of knowledge to aid future policy decision-making.

Increase Scope and Improve Quality of Evaluation of Policy and Practices

Evaluations of policies can be complex because they involve costs and benefits distributed across multiple parties. The effectiveness of policies and practices could be better understood with systematic studies and improved data, greater rigor, and broader scope. This more precise consideration of return on investment, while complex, could advance the understanding of policy and effectiveness of practice.

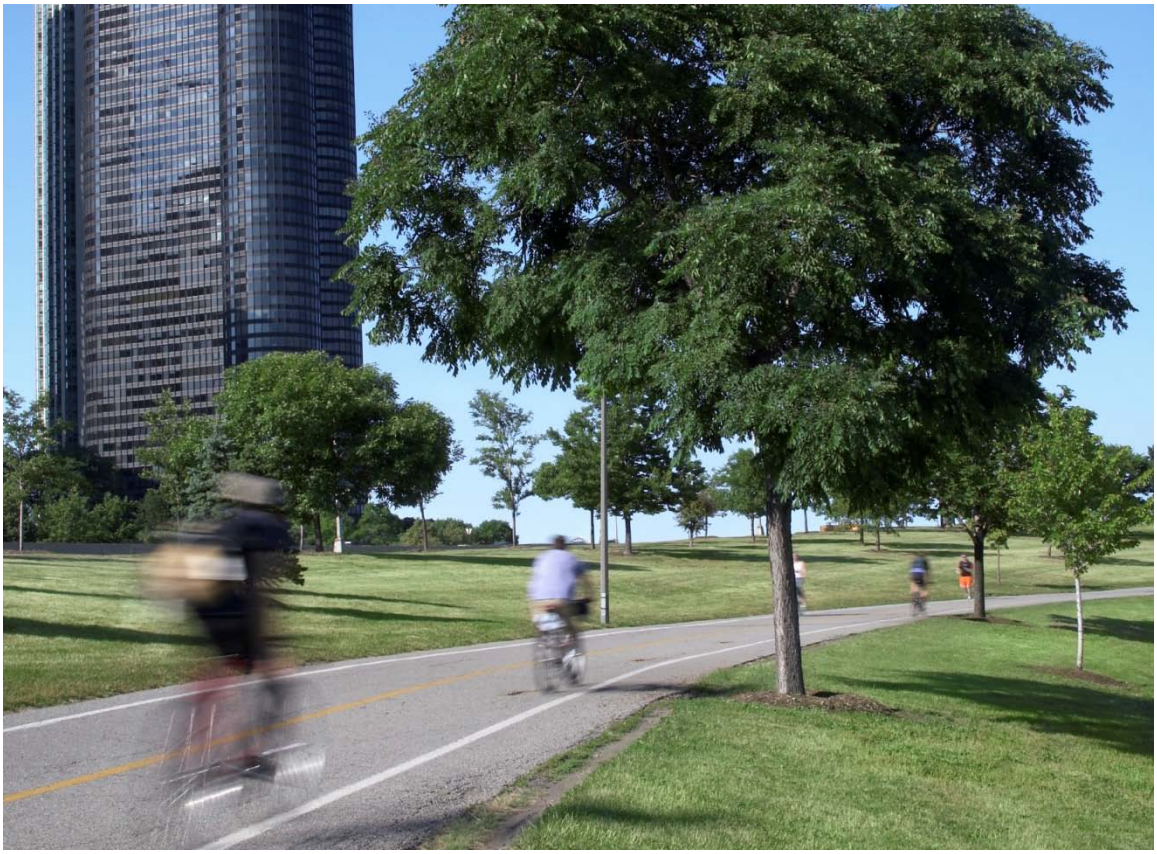
Improve Data Systems and Data Gathering Methods

Research on transportation and health would benefit from improved data collection and data systems for emissions and air quality, climate change, traffic injury and fatality records, modes of travel, bicyclist and pedestrian counts, sidewalk/bicycle infrastructure inventories (such as location, mileage, and condition), and transit system inventories (such as type, location, mileage, ridership, fleet size, and number of stops). Timeliness, quality, and ease of access are issues for many data systems. Linkage would further augment the usefulness and accessibility of data (e.g. linking medical costs to disease and injury outcomes associated with transportation systems).

Identify Best Practices for Increasing Transportation Health Equity

People may lack personal mobility for a variety of reasons including disability, young or old age, low income, unwillingness to drive a car, or remoteness of residence. A lack of personal mobility may put access to jobs, services, and even social support out of reach, and may have deleterious effects on a person's health. Additionally, some communities face environmental issues related to transportation such as poor air and water quality, noise, and issues of displacement when major highways are built or expanded. Work is needed to identify evidence-based best practices for engaging impacted communities in transportation decision-making, and ensuring equal access to the benefits of transportation and freedom from the negative effects.

Chapter 1. Policies that Improve the Environment and Environmental Public Health



1 Introduction: Policies that Improve the Environment and Environmental Public Health

Chapter 1 presents policies that would reduce the transportation system's impacts on the environment and environmental public health, chiefly through reducing the negative effects of transportation-related emissions. This can be accomplished through two approaches: reducing the amount of emissions that are generated and reducing exposure to these emissions when they do occur.

Tailpipe emissions, which are the by-products of fuel combustion, and emissions from electricity-generating sources (in the case of electric-powered vehicles) have the most direct impact on the environment and human health. Their health effects are well-documented—higher incidence of:

respiratory disease (such as asthma and chronic obstructive pulmonary disease), cardiovascular disease, and adverse pregnancy outcomes. Pregnant women, children, and the elderly are the most vulnerable.[1,2]

Yearly costs incurred to treat related diseases and the costs incurred by the premature deaths associated with exposure to these emissions range from $50 to $80 billion adjusted to 2008 dollars.[3] In addition to financial costs, there are losses in productivity; one impact indicator is missed days at school or at work. In 2008, 58.7 percent[4] of all child asthma sufferers and 33.2 percent[5] of adult asthma sufferers missed some school or work that year as a result of an attack.

On the larger-scale level of environmental health, one of the largest impacts from transportation-related emissions is the generation of greenhouse gases—carbon dioxide, primarily—which are associated with climate change.

Opportunities for Improving the Environment and Environmental Public Health

Very substantial progress can be achieved by reducing emissions and reducing exposure to emissions when they occur. We have identified nine policies within three areas where substantial improvements in environmental health can be made. The three areas are:

- Reduce human exposure to transportation-related emissions
- Reduce transportation's contribution to climate change
- Promote a reduction in vehicle-miles travelled through pricing mechanisms

Reduce Human Exposure to Transportation-Related Emissions

Transportation-related emissions with the most direct effect on human health include carbon monoxide, nitrogen dioxide, ozone (the primary ingredient in smog), particulate matter, sulfur dioxide, and toxins such as lead.[6]

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1 Boothe, V. and D.G. Schendell. 2008. Potential Health Effects Associated with Residential Proximity to Freeways and Primary Roads; Review of the Literature 1999-2006. *Journal of Environmental Health*, 70 (8): 33-41, 55-56.

2 Friedman, M.S., K.E. Powell, et al. 2001. Impact of Changes in Transportation and Commuting Behaviors During the 1996 Summer Olympic Games in Atlanta on Air Quality and Childhood Asthma. *The Journal of the American Medical Association,* 285 (7): 897-905.

3 American Public Health Association. 2010. *The Hidden Health Costs of Transportation.* Available at: http://www.apha.org/NR/rdonlyres/F84640FD-13CF-47EA-8267E767A1099239/0/HiddenHealthCostsofTransportationShortFinal.pdf [accessed April 21, 2011].

4 Centers for Disease Control and Prevention, National Center for Health Statistics. 2008. National Health Interview Survey. *Proportion of Children Aged 5 to 17 Years with Asthma Who Miss School Days, Percent.* Available at: http://www.healthindicators.gov/Indicators/Missedschooldays_1410/Profile/Data [accessed April 25, 2010].

5 Centers for Disease Control and Prevention, National Center for Health Statistics. 2008. National Health Interview Survey. *Proportion of Adults Aged 18 to 64 Years with Asthma Who Miss Work Days, Percent.* Available at: http://www.healthindicators.gov/Indicators/Missed-work-days_1411/National_0/Profile/Data [accessed June 13, 2011].

6 U.S. Environmental Protection Agency. 2011. *National Ambient Air Quality Standards.* Available at: http://www.epa.gov/air/criteria.html [accessed May 22, 2011].

Short-term exposure to these pollutants can exacerbate existing symptoms for those with asthma and chronic obstructive pulmonary disease, along with other respiratory diseases.[7] Populations that are exposed over longer terms—people living near high-traffic roadways, for example—experience excess rates of cardiopulmonary mortality,[8,9] as well as adverse pregnancy outcomes such as pre-term birth and low birth weight.[10,11]

The adoption of advanced emission control devices and clean-engine technologies, in addition to tighter fuel efficiency standards, have resulted in reduced vehicle emissions, but until the economic downturn, the total number of vehicle-miles traveled was steadily increasing, counteracting some of these technological and regulatory gains.[12]

Steps to reduce exposure to transportation-related emissions include: improving air quality monitoring systems to give individuals and communities the information they need to make healthier choices; separating high-polluting facilities—especially those that have high rates of "fine" particulates, those that measure 2.5 micrometers across or less ($PM_{2.5}$)—from vulnerable populations; and further reductions in tailpipe emissions and improvements in fuel efficiency.

Reduce the Transportation System's Contribution to Climate Change

Greenhouse gases in the atmosphere trap heat and contribute to rising surface temperatures. This can trigger a multitude of mechanisms—including weather patterns and sea level rise—that can have adverse environmental health effects.[13] From 1990 to 2009, transportation's total greenhouse gas emissions (nearly all of which were carbon dioxide) rose 17 percent.[14] Put another way, in 2009, transportation was responsible for 33 percent of total carbon dioxide emissions, nearly 64 percent of which were from gasoline consumption for personal use.[15]

Converting transportation to low-carbon power, such as natural gas, hydrogen, and wind-, solar-, or natural gas-generated electricity will decrease transportation's contribution to climate change.

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7 Brunekreef, B. and S.T. Holgate. 2002. Air Pollution and Health. *The Lancet*, 360 (9341): 1233-1242.

8 Gan, W.Q., L. Tamburic, et al. 2010. Changes in Residential Proximity to Road Traffic and the Risk of Death from Coronary Heart Disease. *Epidemiology*, 21 (5): 642-649.

9 Ostro, B., M. Lipsett, et al. 2010. Long-Term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study. *Environmental Health Perspectives*, 118: 363-369.

10 Wu, J., M. Wilhelm, J. Chung and B. Ritz. 2011. Comparing Exposure Assessment Methods for Traffic-Related Air Pollution in an Adverse Pregnancy Outcome Study. *Environmental Research*, 111 (5): 685-92.

11 Brauer, M., C. Lencar, et al. 2008. A Cohort Study of Traffic-Related Air Pollution Impacts on Birth Outcomes. *Environmental Health Perspectives*, 116 (5).

12 U.S. Environmental Protection Agency. 2011. 2011 *U.S. Greenhouse Gas Inventory Report*. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009. Chapter 3. Available at: http://www.epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Chapter-3-Energy.pdf [accessed May 17, 2011].

13 Centers for Disease Control and Prevention. 2009. *Policy on Climate Change.* Available at: http://www.cdc.gov/climatechange/pubs/Climate_Change_Policy.pdf [accessed 21 April 2011].

14 U.S. Environmental Protection Agency. 2011. *2011 U.S. Greenhouse Gas Inventory Report*. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009. Chapter 3. Available at: http://www.epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Chapter-3-Energy.pdf [accessed May 17, 2011].

15 Ibid.

Additionally, decreasing the size disparity in the motor vehicle fleet will bring down the overall consumption of fuel and reduce greenhouse gas emissions. Finally, shifting travelers' behavior from driving alone to carpooling, vanpooling, and using active transportation and public transportation is an important way to reduce carbon emissions.

Promote a Reduction in Vehicle-Miles Traveled Through Pricing Measures

The overwhelming number of vehicle-miles traveled (VMT) in the U.S. are made in motor vehicles—some 3 trillion miles in 2007.[16] In 2009, 83 percent of all trips made by the American public were in private vehicles.[17] The other three modes—railroads, transit, and domestic air carrier—account for 11.5 billion VMT combined; by contrast, motor vehicle VMT was more than 3 trillion.[18]

Between 1990 and 2009, the total VMT for passenger cars and light-duty trucks in the U.S. increased by 39 percent, as a result of population growth, economic growth, increasingly dispersed land use practices, and relatively low fuel prices.[19]

To reduce VMT and its impacts, some motor vehicle trips can be replaced by alternatives, such as transit, carpooling, walking, or bicycling; or they can be made when there is less congestion; or trips can be combined. Changing the price of operating a motor vehicle through user fees or other charges; changing the price of access to road facilities depending on time of day and other factors (while providing adequate support for alternatives); and changing the price of access to parking depending on time of day and demand, can all promote changes in behavior that result in fewer VMT.

Chapter 1 at a Glance

In this chapter, we examine three policies that improve the environment and environmental public health:

1.1 Reduce Human Exposure to Transportation-Related Emissions

1.2 Reduce Transportation's Contribution to Climate Change

1.3 Promote a Reduction in Vehicle-Miles Traveled Through Pricing Measures

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16 Research and Innovative Technology Administration Bureau of Transportation Statistics. 2009. *Transportation Statistics Annual Report. U.S. Vehicle-Miles: 1998-2007.* Available at: http://www.bts.gov/publications/transportation_statistics_annual_report/2009/html/chapter_01/table_01_02_10.html [accessed April 21, 2011].

17 Federal Highway Administration. Summary of Travel Trends: 2009 National Household Travel Survey. Available at: http://nhts.ornl.gov/2009/pub/stt.pdf [accessed July 8, 2011]

18 Research and Innovative Technology Administration Bureau of Transportation Statistics. 2009. *Transportation Statistics Annual Report. U.S. Vehicle-Miles: 1998-2007.* Available at: http://www.bts.gov/publications/transportation_statistics_annual_report/2009/html/chapter_01/table_01_02_10.html [accessed April 21, 2011].

19 Ibid.

1.1 Reduce Human Exposure to Transportation-Related Emissions

1.1.1 Background: Reduce Human Exposure to Transportation-Related Emissions

Prevalence of and Human Exposure to Transportation-Related Emissions

Transportation-related emissions with the most direct effect on human health include carbon monoxide, nitrogen dioxide, ozone, (the primary ingredient in smog), particulate matter (especially the "fine" particulates, known as $PM_{2.5}$), sulfur dioxide, and toxics such as lead.[20]

Fifty-eight percent of people in the U.S. live in areas with unhealthful levels of ozone. Looking at the two most vulnerable age groups, more than 20.4 million adults over age 65 and almost 44 million children under age 18 live in counties with unhealthy ozone levels. Approximately one in three Americans is at elevated risk for $PM_{2.5}$-related health impacts.[21]

Impact of Transportation-Related Emissions on Disease

Exposure to traffic-related pollutants is associated with asthma, non-asthma respiratory symptoms, impaired lung function, and cardiovascular mortality and morbidity.[22,23] Populations that are exposed over longer terms—people living near high-traffic roadways, for example—experience increased levels of cardiopulmonary mortality,[24,25] as well as adverse pregnancy outcomes such as pre-term birth and low birth weight.[26,27] Particulate exposure has been directly associated with decreases in lung function in older adults already suffering from chronic

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20 U.S. Environmental Protection Agency. 2011. *National Ambient Air Quality Standards.* Available at: http://www.epa.gov/air/criteria.html [accessed May 22, 2011].

21 U.S. Environmental Protection Agency. 2010. *Fine Particle Designations. Particulate Matter FAQs.* Available at: http://www.epa.gov/pmdesignations/faq.htm#0 [accessed November 18, 2010].

22 Health Effects Institute. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. HEI Panel on the Health Effects of Traffic-Related Air Pollution. Available at: http://pubs.healtheffects.org/view.php?id=334 [accessed on June 21, 2011].

23 Brunekreef, B. and S.T. Holgate. 2002. Air pollution and Health. *The Lancet*, 360 (9341): 1233-1242.

24 Gan, W., Q.L. Tamburic, et al. 2010. Changes in Residential Proximity to Road Traffic and the Risk of Death from Coronary Heart Disease. *Epidemiology*, 21 (5): 642-649.

25 Ostro, B., M. Lipsett, et al. 2010. Long-Term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study. *Environmental Health Perspectives*, 118: 363-369.

26 Wu, J., M. Wilhelm, J. Chung and B. Ritz. 2011. Comparing Exposure Assessment Methods for Traffic-Related Air Pollution in an Adverse Pregnancy Outcome Study. *Environmental Research*, 111 (5): 685-92.

27 Brauer, M., C. Lencar, et al. 2008. A Cohort Study of Traffic-Related Air Pollution Impacts on Birth Outcomes. *Environmental Health Perspectives*, 116 (5).

obstructive pulmonary disease and in children with asthma.[28] Long-term exposure to $PM_{2.5}$ is associated with increased risk of cardiopulmonary mortality.[29]

Generally, children and infants are the most susceptible to air pollutants because of their increased levels of physical activity and the fact that their lungs are still developing.[30] Financially disadvantaged populations and minorities are disproportionately impacted by air pollution because they are more likely to live in areas with worse air quality.[31]

Potential for Reducing Exposure to Transportation-Related Emissions

Evidence of the negative health impacts of traffic-related air pollutants has led to increasingly strict controls, resulting in reductions in motor vehicle emissions and subsequent improvements in air quality. However, many of these gains have been offset by an increase in vehicle-miles traveled (rising rapidly until the economic downturn) and the increasing urbanization of the population, which puts homes, workplaces, and schools near highways.[32,33,34]

National strategies for reducing exposure to transportation-related emissions have included an extensive system for monitoring pollution, policies to separate high-pollution sources from vulnerable populations, and encouraging adoption of technologies to reduce emissions.

We examine four policies that have contributed or could contribute further to these strategies.

Policy 1: Improve monitoring of locations where pollution sources are concentrated

Policy 2: Locate residential and community facilities away from transportation-related emissions

Policy 3: Minimize exposure to $PM_{2.5}$

Policy 4: Encourage adoption of technologies to reduce vehicle emissions

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28 Tranga, C. et al. 2006. Effect of Particulate Air Pollution on Lung Function in Adult and Pediatric Subjects in a Seattle Panel Study. *Chest*, 129 (6): 1614-1622.

29 Ostro B., M. Lipsett, P. Reynolds, D. Goldberg, A. Hertz, C. Garcia, et al. 2010. Long-Term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study. *Environmental Health Perspectives* 118: 363-369.

30 Schwartz, J. 2004. Air Pollution and Children's Health. *Pediatrics*. American Academy of Pediatrics. 113 (S3): 1037-1043.

31 Houston, D., J. Wu, P. Ong, A. Winer. 2004. Structural Disparities of Urban Traffic in Southern California: Implications for Vehicle-Related Air Pollution Exposure in Minority and High-Poverty Neighborhoods. University of California, Los Angeles. Journal of Urban Affairs 26 (5): 565-592.

32 U.S. Environmental Protection Agency. 2011. 2011 *U.S. Greenhouse Gas Inventory Report*. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009*. Chapter 3. Available at: http://www.epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Chapter-3-Energy.pdf [accessed May 17, 2011].

33 Balbus, J.M. and D.Y. Triola. 2005. Transportation and Health. In H. Frumkin ed. *Environment Health: from global to local*. San Francisco, Jossey-Bass: 414-453.

34 Health Effects Institute. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. HEI Panel on the Health Effects of Traffic-Related Air Pollution. Available at: http://pubs.healtheffects.org/view.php?id=334 [accessed on June 21, 2011].

1.1.2 Impact of Policies: Reduce Human Exposure to Transportation-Related Emissions

Policy 1—Improve monitoring of locations where pollution sources are concentrated

Definition

The U.S. Environmental Protection Agency (EPA) maintains the nation's chief repository of ambient air quality data, which is obtained from more than 10,000 monitors operated by state, tribal, and local agencies.[35,36]

History of Deployment

The 1970 Clean Air Act provides the legislative basis for the EPA's program of air pollution monitoring and regulation by establishing the EPA's enforcement authority, setting national standards and state performance standards for ambient air quality, and establishing regulations for stationary sources (e.g., factories, power plants, and the like) and motor vehicle emissions. Major amendments were made in 1977 and 1990, expanding the Clean Air Act's scope.[37]

Effectiveness and Impact

The EPA's network of monitors tracks ambient air quality in most parts of the country where there are significant transportation-related emissions. Without this system, the implementation of current regulation and documentation of exposure and subsequent disease would not be possible. A geographically more comprehensive monitoring network and further development of statistical models would enhance the system's effectiveness.

Economic Factors

According to the EPA, the benefits of Clean Air Act programs in 2010 totaled about $110 billion in prevented illnesses and premature deaths versus a cost of $27 billion.[38] While economic factors associated with monitoring air quality are not broken out separately, Clean Air Act programs would not be possible without an extensive system for monitoring exposure and related disease outcomes.

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35 U.S. Environmental Protection Agency. *Technology Transfer Network (TTN) Air Quality System (AQS)* Available at: http://www.epa.gov/ttn/airs/airsaqs/index.htm [accessed May 16, 2011].

36 U.S. Environmental Protection Agency. *Monitoring Pollutant Concentration in the Ambient Air.* Available at: http://www.epa.gov/apti/course422/ce3.html [accessed November 17, 2010].

37 U.S. Environmental Protection Agency. *History of the Clean Air Act.* Available at: http://epa.gov/oar/caa/caa_history.html [accessed May 22, 2011].

38 U.S. Environmental Protection Agency. *Benefits and Costs of the Clean Air Act.* Available at: http://yosemite.epa.gov/EE/epa/eerm.nsf/vwRepNumLookup/EE-0295A?OpenDocument [accessed June 15, 2011].

Conclusion

The current monitoring system should be continued and enhanced. For example, areas with persistently high ozone levels, mostly large cities, warrant more extensive monitoring of ozone and its precursors.[39] Also, vulnerable populations—people with heart and lung diseases, older adults, children, and people with diabetes—should be protected from excessive pollution exposure. Simultaneously, additional information about the effectiveness and costs associated with air quality monitoring is needed.

Policy 2—Locate residential and community facilities away from transportation-related emissions

Definition

Proximity to sources of transportation-related emissions increases the probability of adverse health effects.[40]

History of Deployment

This is a developing area of research and regulatory policy. Policies are being developed for some facilities. For example, in November 2010, the Environmental Protection Agency (EPA) issued draft voluntary guidelines for selecting locations for schools, because they serve children, who are especially vulnerable to air pollution. Proximity to air pollution sources—including traffic—is one of the considerations.[41]

Effectiveness and Impact

The distance at which adverse health effects decline significantly varies by pollutant and is not well-documented for all of the major transportation-related emissions. However, living near high-traffic roadways is associated with adverse health effects.[42] The effects of transportation-related emissions on asthma are strongest among those who live within 150 meters (0.09 miles) of a main road.[43,44] One class of pollutant that has been extensively studied is fine particulates—those that

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39 U.S. Environmental Protection Agency. *Air Pollution Monitoring*. Available at: http://epa.gov/airquality/montring.html [accessed November 17, 2010].

40 Health Effects Institute. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. HEI Panel on the Health Effects of Traffic-Related Air Pollution. Available at: http://pubs.healtheffects.org/view.php?id=334 [accessed on June 21, 2011].

41 U.S. Environmental Protection Agency. 2010. *School Siting Guidelines.* Available at: http://www.epa.gov/schools/siting/criteria.html# [accessed March 28, 2011].

42 Boothe, V.L. and D.G. Shendell. 2008. Potential Health Effects Associated with Residential Proximity to Freeways and Primary Roads: Review of Scientific Literature, 1999-2006. *Journal of Environmental Health*, 70 (8): 33-41, 55-56.

43 Venn, A.J., S.A. Lewis, M. Cooper, R. Hubbard, J. Britton. 2001. Living Near A Main Road and the Risk of Wheezing Illness in Children. *American Journal of Respiratory and Critical Care Medicine*, 164: 2177-2180.

44 Environmental Defense Fund. 2006. Motor Vehicle Air Pollution and Public Health: Asthma and Other Respiratory Effects.

are 2.5 micrometers or less in diameter ($PM_{2.5}$). Exposure is greatest within the first 300 meters (0.18 miles) of a major source, with levels decreasing to ambient upwind concentrations at distances greater than that.[45]

Economic Factors

There is insufficient data to determine economic factors involved in locating key facilities away from major roadways.

Conclusion

Proximity to roadways with heavy traffic is associated with disease outcomes. Land use planning requirements for new facilities serving vulnerable populations and for road projects anticipated to carry high levels of traffic should take into consideration proximity of vulnerable populations to transportation-related emissions.

Policy 3—Minimize exposure to $PM_{2.5}$

Definition

"Fine" particulate matter is defined as $PM_{2.5}$, 2.5 micrometers or less in diameter. It poses a health threat because its small size means it can become deeply lodged in the lungs.[46] Sources of $PM_{2.5}$ include motor vehicle engines—especially older diesel engines—power plants, wood burning, and some industrial processes.[47,48]

History of Deployment

U.S. regulations setting limits for particulate emissions date back to 1971. In 1987, they were updated to include a standard for PM_{10}, targeting particles with a diameter of 10 micrometers or less.[49] In 1997, the EPA revised the PM standard to include $PM_{2.5}$. In September 2006, the agency lowered the acceptable levels of $PM_{2.5}$ emissions.[50]

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45 California Air Resources Board. 2003. *Health Impacts of Research on Fine and Ultrafine PM Exposure.* Available at: http://www.arb.ca.gov/research/pmr/pmr-sum1.htm [accessed November 18, 2010].

46 U.S. Environmental Protection Agency. 2010. *Fine Particle Designations. Particulate Matter FAQs.* Available at: http://www.epa.gov/pmdesignations/faq.htm#0 [accessed November 18, 2010].

47 Ibid.

48 U.S. Environmental Protection Agency. *Particulate Matter (PM-10).* Available at: http://www.epa.gov/airtrends/aqtrnd95/pm10.html [accessed June 16, 2011].

49 Ibid.

50 U.S. Environmental Protection Agency. 2006. *PM Standards Revision.* Available at: http://www.epa.gov/PM/naaqsrev2006.html [accessed November 17, 2010].

Effectiveness and Impact

$PM_{2.5}$ exposure is greatest within the first 300 meters (0.18 miles) of a major source, with levels decreasing to ambient upwind concentrations at distances greater than 300 meters.[51] Long-term exposure to $PM_{2.5}$ is associated with increased risk of cardiopulmonary mortality.[52] Limiting $PM_{2.5}$ emissions within 300 meters of residential areas would greatly reduce exposure.

Economic Factors

The monetized value of the public health impacts of $PM_{2.5}$ exposure is estimated to be in the tens of billions of dollars annually, which is significant enough to make its reduction a consideration in setting transportation policy.[53]

Conclusion

To reduce the negative impacts of $PM_{2.5}$ exposure on vulnerable populations, the distance from high-traffic locations should be used as a consideration in development of facilities used by vulnerable populations or facilities where long-term exposure will result.

Policy 4—Encourage adoption of technologies to reduce vehicle emissions

Definition

Advanced motor vehicle emission control technologies for gasoline engines include catalytic converters, advanced ignition and fuel injection systems, on-board computers, and electronic controls, which are all standard components of today's new cars.[54] For diesel engines, there are numerous retrofit technologies for existing engines. They include: catalyst mufflers, diesel particulate filters, crankcase filtration systems, diesel oxidant catalysts conversions, and cetane enhancers.[55]

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51 California Air Resources Board. 2003. Health Impacts of Research on Fine and Ultrafine PM Exposure. Available at: http://www.arb.ca.gov/research/pmr/pmr-sum1.htm [accessed November 18, 2010].

52 Ostro B., M. Lipsett, P. Reynolds, D. Goldberg, A. Hertz, C. Garcia, et al. 2010. Long-Term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study. *Environmental Health Perspectives*, 118: 363-369.

53 Levy J.I., J.J. Buonocore and K. von Stackelberg. 2010. Evaluation of the Public Health Impacts of Traffic Congestion: A Health Risk Assessment. *Environmental Health*, 9: 65.

54 Manufacturers of Emission Controls Association News. 2000. *Advanced Motor Vehicle Emission Control Technology Celebrates 25th Anniversary.* Available at: http://www.meca.org/galleries/default-file/25thannivpr.pdf [accessed May 22, 2011].

55 U.S. Environmental Protection Agency. *Verified Technologies.* Available at: http://epa.gov/cleandiesel/verification/verif-list.htm [accessed May 22, 2011].

History of Deployment

Starting in 1970, automobiles sold in the United States were required to meet emissions standards for six criteria pollutants.[56] In the 1975 model year, the first automobiles with catalytic converters were sold on the U.S. market,[57] simultaneously with the broader rollout of unleaded gasoline that the converters required. The following decades saw changes in fuel formulas, combined with engine technologies.[58]

As of 2008, overall national air quality has improved significantly compared with 1990: ozone is down 14 percent, lead is down 78 percent, nitrogen dioxide has fallen 35 percent, carbon monoxide has been cut 68 percent, and sulfur dioxide has been reduced by 59 percent. Annual $PM_{2.5}$ concentrations dropped by 17 percent between 2001 and 2008.[59]

In October 2010, the EPA and the National Highway Traffic Safety Administration announced a joint fuel standards program to regulate greenhouse gas emissions and fuel economy as part of a package that included the first-ever greenhouse gas emissions standards for heavy-duty vehicles.[60]

Effectiveness and Impact

The development and enforcement of greenhouse gas emission standards will create significant reductions in fuel consumption and emissions for gasoline- and diesel-powered heavy trucks and commercial vehicles.[61]

Economic Factors

The EPA estimates that the joint fuel standards program will provide $41 billion in net benefits over the lifetime of model year 2014 to 2018 vehicles.[62,63]

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56 U.S. Environmental Protection Agency. *National Ambient Air Quality Standards.* Available at: http://www.epa.gov/air/criteria.html [accessed May 22, 2011].

57 Manufacturers of Emission Controls Association News. 2000. *Advanced Motor Vehicle Emission Control Technology Celebrates 25th Anniversary.* Available at: http://www.meca.org/galleries/default-file/25thannivpr.pdf [accessed May 22, 2011].

58 U.S. Environmental Protection Agency. 1999. *Air Trends*. Available at: http://www.epa.gov/airtrends/aqtrnd99/pdfs/table2-2.pdf [accessed May 18, 2011].

59 U.S. Environmental Protection Agency. 2010. *Our Nation's Air.* Available at: http://www.epa.gov/airtrends/2010/report/highlights.pdf [accessed May 18, 2011.]

60 U.S. Environmental Protection Agency. 2010. EPA and NHTSA Announce a First Step in the Process for Setting Future Greenhouse Gas and Fuel Economy Standards for Passenger Cars and Light Trucks. EPA-420-F-10-051. Available at: http://yosemite.epa.gov/opei/rulegate.nsf/byRIN/2060-AP61 [accessed June 15, 2011].

61 U.S. Environmental Protection Agency. *Regulatory Initiatives.* Available at: http://www.epa.gov/climatechange/initiatives/index.html [accessed November 22, 2010].

62 Ibid.

63 U.S. Department of Transportation. 2010. *DOT, EPA Propose the Nation's First Greenhouse Gas and Fuel Efficiency Standards for Trucks and Buses.* EPA News Release. Available at: http://yosemite.epa.gov/opa/admpress.nsf/e77fdd4f5afd88a3852576b3005a604f/9b3706622f4ac560852577c7005ea140!OpenDocument [accessed June 15, 2011].

Conclusion

There are a variety of advanced motor vehicle emission control technologies that have already had enormous impacts in reducing emissions and associated disease. The joint fuel standards proposal will provide impetus for another significant gain in reducing emissions.

1.1.3 Conclusions: Reduce Human Exposure to Transportation-Related Emissions

Reducing human exposure to transportation-related emissions that most directly affect human health—carbon monoxide, nitrogen dioxide, ozone, (the primary ingredient in smog), particulate matter, sulfur dioxide, and toxins such as lead—can be accomplished through reducing emissions and reducing exposure.

A number of policies can achieve these goals: expanding current monitoring systems by focusing on, for example, urban areas with persistently high ozone levels; planning long-term facilities and those that serve vulnerable populations in a way that provides an adequate buffer, with special attention paid to $PM_{2.5}$ exposure; continue to build on the success of advanced motor vehicle emission control technologies and fuel efficiency efforts that have already had enormous impacts in reducing emissions and associated disease.

1.2 Reduce Transportation's Contribution to Climate Change

1.2.1 Background: Reduce Transportation's Contribution to Climate Change

Prevalence of and Threat from Greenhouse Gas Emissions

Greenhouse gases—primarily carbon dioxide or CO_2—trap heat and contribute to rising surface temperatures, which can trigger a multitude of mechanisms—including changing weather patterns and sea level rise—that can have adverse environmental health effects.[64] Some greenhouse gases occur and are emitted through natural processes. Others are created and emitted solely as a result of human activities.[65]

From 1990 to 2009, transportation's total greenhouse gas emissions (nearly all of which were CO_2) rose 17 percent. Put another way, in 2009, transportation was responsible for 33 percent of

64 Centers for Disease Control and Prevention. 2009. *Policy on Climate Change.* Available at: http://www.cdc.gov/climatechange/pubs/Climate_Change_Policy.pdf [accessed April 21, 2011].

65 U.S. Environmental Protection Agency. *Greenhouse Gas Emissions.* Available at: http://epa.gov/climatechange/emissions/index.html [accessed March 25, 2011].

total CO_2 emissions, and 64 percent of those were from passenger cars and light-duty trucks.[66] Additional transportation-related sources of greenhouse gas emissions are the result of the manufacturing of vehicles, as well as the construction of roadways and other infrastructure.[67]

Without a change in current policies, transportation's greenhouse gas emissions are expected to grow by about 10 percent by 2035, and will account for one-quarter of all global transportation emissions.[68]

Impact on Climate Change and Subsequent Health Outcomes

The effects of climate change on human health are diverse.[69] For example, large fluctuations in temperature and rainfall can cause vector-borne and water-borne disease epidemics, heat exhaustion, hypothermia, and related respiratory and cardiovascular disease. Sea-level rise can cause flooding and economic dislocation, including the destruction of food crops.[70,71]

Potential for Reducing Transportation's Impact on Climate Change

There has been little progress in reducing transportation's greenhouse gas emissions, which are closely tied to overall fuel consumption, which has been rising steadily. There is potential to reduce transportation sector emissions by up to 65 percent from current levels by 2050 through improvements in vehicle efficiency, use of less carbon-intensive fuels, and alterations in travel behavior.[72] Plug-in electric vehicles (PEVs) are gaining attention as a way to replace petroleum with electricity generated from cleaner, lower-carbon sources.[73] For the gasoline-powered vehicle fleet, reducing the overall size of vehicles through regulations and incentives such as the

66 U.S. Environmental Protection Agency. 2011. *2011 U.S. Greenhouse Gas Inventory Report*. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009. Chapter 3. Available at: http://www.epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Chapter-3-Energy.pdf [accessed May 17, 2011].

67 Greene, D.L. and S.E. Plotkin. 2011. *Reducing Greenhouse Gas Emissions from U.S. Transportation.* Pew Center on Global Climate Change. Available at: http://www.environmentportal.in/files/Reducing_GHG_from_transportation.pdf [accessed June 18, 2011].

68 U.S. Environmental Protection Agency. *Greenhouse Gas Emissions.* Available at: http://epa.gov/climatechange/emissions/index.html [accessed March 25, 2011].

69 The Interagency Working Group on Climate Change and Health. 2010. *A Human Health Perspective on Climate Change*. Environmental Health Perspectives and the National Institute of Environmental Health Sciences. Available at: http://www.niehs.nih.gov/about/od/programs/climatechange/index.cfm [accessed June 18, 2011].

70 Centers for Disease Control and Prevention. Climate Change and Public Health. Cardiovascular Disease and Stroke. Available at: http://www.cdc.gov/climatechange/effects/stroke.htm [accessed April 20, 2011].

71 McMichael, A.J. et al. Eds. 2003. *Climate Change and Human Health—Risks and Responses.* World Health Organization.

72 Greene, D.L. and S.E. Plotkin. 2011. *Reducing Greenhouse Gas Emissions from U.S. Transportation.* Pew Center on Global Climate Change. Available at: http://www.environmentportal.in/files/Reducing_GHG_from_transportation.pdf [accessed June 18, 2011].

73 *Plug-in Electric Vehicles: A Practical Plan for Progress.* 2011. The Report of an Expert Panel. School of Public and Environmental Affairs. Indiana University. Available at: http://www.indiana.edu/~spea/pubs/TEP_combined.pdf [accessed June 16, 2011].

Corporate Average Fuel Economy (CAFE) program could reduce fuel consumption and thereby reduce greenhouse gas emissions.[74]

Policies to Reduce Transportation's Contribution to Climate Change

The policy suggestions discussed here are ways to decrease carbon emissions without changing overall travel behavior. In addition to technological solutions such as electric vehicles or reduction in vehicle weights, travelers who choose to drive fewer miles in single occupancy vehicles also reduce carbon emissions. This can be achieved by shifting to a different mode of transportation. Reduction in vehicle-miles traveled (VMT) through mode shift away from single-occupancy vehicles is an overarching strategy to reduce vehicle carbon emissions. Reducing VMT through mode shift offers multiple co-benefits. Shifting to carpooling or vanpooling takes cars off the road, contributing to a reduction in traffic congestion and traffic emissions, reduces wear and tear on roads and subsequent maintenance, and increases social interaction. Shifting from single-occupancy vehicles to public transit, bicycling or walking has all the benefits of carpooling, and it also contributes to the traveler getting the recommended amount of physical activity.

We discuss two policies to reduce transportation's contribution to climate change by reducing carbon outputs of motor vehicles.

Policy 1: Encourage electric vehicle propulsion from clean sources

Policy 2: Give incentives to carmakers to reduce weight disparities within their fleets

These policies emphasize technological solutions to carbon emissions, however, another solution not analyzed in this report is encouraging travelers to shift from driving alone to carpooling, vanpooling, and using active transportation and public transportation.

1.2.2 Impact of Policies: Reduce Transportation's Contribution to Climate Change

Policy 1—Encourage electric vehicle propulsion from clean sources

Definition

The electric vehicle technology being developed for broad market introduction with the greatest potential for greenhouse gas reduction is the "plug-in" electric vehicle (PEV), which can recharge by connecting to the power grid. Many vehicles currently in development are hybrids—plug-in hybrid electric vehicles, or PHEVs—which can switch to gasoline as a way of extending their

[74] U.S. Department of Transportation National Highway Traffic Safety Administration. *CAFE Overview - Frequently Asked Questions.* Available at: http://www.nhtsa.gov/cars/rules/cafe/overview.htm [accessed April 5, 2010].

range.[75] Within the bounds of current, market-ready technology, electric vehicles are classed as 10-mile vehicles, which can drive that distance on all-electric power, and 40-mile vehicles.[76]

History of Deployment

Interest in PEVs and PHEVs has grown with improvements in battery technology[77] and with the 2009 U.S. government announcement committing federal research dollars to invest in technology with the goal of having half a million PEVs on the road by 2015.[78] Hybrid and all-electric vehicles are currently available from some of the largest domestic and foreign auto manufacturers; more than 20 additional PEV models are expected by the end of 2012.[79]

Effectiveness and Impact

Powering vehicles with electricity can significantly reduce transportation's greenhouse gas emissions as long as the electricity is generated from low-carbon sources (natural gas, wind, water, and solar). For a significant reduction in greenhouse gas emissions, tens of millions of PEVs will have to be in use. For purposes of comparison, by 2010—13 years after Toyota Motor Corporation's Prius was introduced—1,888,971 hybrid vehicles had been sold in the United States.[80]

The impact on greenhouse gas emissions is difficult to predict. Among the unknowns: level of market penetration by PEVs and PHEVs; development of battery technology to increase the distance that can be driven on battery power; and level of emissions associated with the electricity used for powering vehicles.[81]

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75 *Plug-in Electric Vehicles: A Practical Plan for Progress.* The Report of an Expert Panel. 2011. School of Public and Environmental Affairs. Indiana University. Available at: http://www.indiana.edu/~spea/pubs/TEP_combined.pdf [accessed May 18, 2011].

76 *Transitions to Alternative Transportation Technologies—Plug-In Hybrid Electric Vehicles.* 2010. Board on Energy and Environmental Systems. The National Academies Press. Available at: http://www.nap.edu/catalog.php?record_id=12826 [accessed May 19, 2011].

77 Ibid.

78 Markel, T. 2010. *Plug-in Electric Vehicle Infrastructure: A Foundation for Electrified Transportation.* National Renewable Energy Laboratory. Golden, CO. Presented at MIT Energy Initiative Transportation Electrification Symposium. April 8, 2010. Available at: http://web.mit.edu/mitei/docs/reports/trans-infrastructure-markel.pdf [accessed May 19, 2011].

79 Cullen, G. 2011. *Impact of Grid Integration and Diffusion: Reliability and Other Impacts of EVs and Alternative fuel vehicles.* Electric Drive Transportation Association. Available at: http://docs.google.com/viewer?a=v&q=cache:UUIp5M9F1KQJ:www.eei.org/meetings/Meeting%2520Documents/2011May17EPARegulationCullenPres.pdf+%22Impact+of+Grid+Integration+and+Diffusion%22&hl=en&gl=us&pid=bl&srcid=ADGEEShgsVTijC_6NbCHwqvQ0WFGN8YAbYAPLDC9EhtzmMpQNUW6SFXueNPqQS94GXS9VVpLT0ZGmSNQptoRUHcl2INj8Dsec4PRbHicMkDFPQVv3gygXiLp8tnmQ612JvYQKGSggCa9&sig=AHIEtbQz32Sfm8_ej7tCF2LF_x_Z3-v1AQ [accessed June 16, 2011].

80 Alternative Fuel Vehicles (AFVs) and Hybrid Electric Vehicles (HEVs): *HEV Sales by Model.* Alternative Fuels and Advanced Vehicle Data Center (U.S. DoE). Available at: http://www.afdc.energy.gov/afdc/data/vehicles.html [accessed February 26, 2011].

81 *Transitions to Alternative Transportation Technologies—Plug-In Hybrid Electric Vehicles.* 2010. Board on Energy and Environmental Systems. The National Academies Press. Available at: http://www.nap.edu/catalog.php?record_id=12826 [accessed May 19, 2011].

Economic Factors

PEVs, even with the lowest cost projections using current information, will be considerably more expensive than internal combustion engine vehicles for the near-term. This will slow market penetration, as new-car buyers are conservative in their willingness to invest in untested technologies of uncertain resale value and reliability. Most analyses assume that government subsidies will be required.[82]

For PEVs to achieve the required reliability, significant investments in charging infrastructure and adjustments to the electrical grid to absorb the added demand as well as to accept "reverse" charging will have to be made.[83]

Conclusion

The use of electricity to power motor vehicles has the potential to reduce transportation's greenhouse gas emissions, depending on the source of electricity. However, there are numerous uncertainties, such as barriers to market acceptance, driver willingness to make full use of all-electric modes, and the degree of investments in infrastructure required.

Policy 2—Give incentives to carmakers to reduce weight disparities within their fleets

Definition

The current incentive system is the Corporate Average Fuel Economy (CAFE) standard.[84]

History of Deployment

CAFE standards were enacted in 1975 in response to the 1973-74 Arab oil embargo. The original goal was to double new car fuel economy by model year 1985.[85] The original focus on was passenger vehicles, with more lenient requirements for light trucks. Because they were weighted for each automaker based on the fuel economy of its fleet, and weighted by sales for each year, carmakers sought to offset less fuel-efficient models with larger numbers of smaller, more efficient models, which created size disparities in fleets.[86] The standards remained relatively

82 Ibid.

83 Markel, T. 2010. *Plug-in Electric Vehicle Infrastructure: A Foundation for Electrified Transportation.* National Renewable Energy Laboratory. Golden, CO. Presented at MIT Energy Initiative Transportation Electrification Symposium. April 8, 2010. Available at: http://web.mit.edu/mitei/docs/reports/trans-infrastructure-markel.pdf [accessed May 19, 2011].

84 U.S. Department of Transportation National Highway Traffic Safety Administration. *CAFE Overview - Frequently Asked Questions.* Available at: http://www.nhtsa.dot.gov/cars/rules/cafe/overview.htm [accessed April 5, 2010].

85 Ibid.

86 McCarthy, T. 2007. *Auto Mania: Cars, Consumers, and the Environment*. Yale University Press. New Haven, CT.

unchanged for 20 years, resulting in a decrease in fuel economy as a whole, as more exempt light trucks and light truck-type vehicles were purchased.[87]

Starting in 2007, with CAFE II, the standards were tightened and the timeline for complying with them accelerated. Additionally, the method for determining a company's compliance has changed: instead of being able to average its fuel economy rates across all the vehicles in its light truck or passenger vehicle categories, the company has to use each vehicle's actual size (the "footprint" or rectangle formed) as part of its formula for compliance, so that a smaller footprint vehicle has a higher standard to meet, giving incentive to reduce the size disparity of vehicle fleets.[88]

Effectiveness and Impact

By encouraging automakers to reduce the size disparities in their fleets, CAFE II is expected to reduce consumer demand for larger, less fuel-efficient vehicles purchased out of safety concerns.[89]

Economic Factors

Carmakers can comply with CAFE II with existing technology.[90] Insufficient data is available to determine the effect on the cost of new vehicles produced under these rules.

Conclusion

The CAFE II standards create carmaker incentives that could reduce consumer demand for over-sized vehicles and thereby reduce fuel consumption and greenhouse gas emissions associated with climate change.

1.2.3 Conclusions: Reduce Transportation's Contribution to Climate Change

Electric vehicles have the potential to reduce transportation's greenhouse gas emissions, though there are unknowns about driver acceptance and other factors such as infrastructure investments and vehicle costs.

The new CAFE standards that use a size-based indexing system create incentives for carmakers to reduce size disparities in the motor vehicle fleet, which can reduce consumer demand for large vehicles and thereby improve fuel economy and decrease greenhouse gas emissions.

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87 Klier, T. and J. Linn. 2010. Corporate Average Fuel Economy Standards and the Market for New Vehicles. Resources for the Future. Washington, D.C. Available at: http://www.rff.org/RFF/Documents/RFF-DP-10-68.pdf [accessed May 19, 2011].

88 Ibid.

89 Ibid.

90 U.S. Department of Transportation, Environmental Protection Agency and National Highway Traffic Safety Administration. 2010. Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule. *Federal Register*, 75: 25324-25728 Available at: http://federalregister.gov/a/2010-8159 [accessed May 19, 2011].

1.3 Promote a Reduction in Vehicle-Miles Traveled Through Pricing Measures

1.3.1 Background: Promote a Reduction in Vehicle-Miles Traveled Through Pricing Measures

Vehicle-Miles Traveled

Motor vehicles account for nearly all vehicle-miles traveled (VMT) in the U.S.—some 99 percent in 2007. The other three modes—railroads, transit, and domestic air carrier—accounted for 11.5 billion VMT combined; by contrast, motor vehicle VMT was more than 3 trillion. Between 1990 and 2009, the total VMT for passenger cars and light-duty trucks in the U.S. increased by 39 percent, as a result of population growth, economic growth, increasingly dispersed land use practices, and relatively low fuel prices.[91]

Potential Impact of Pricing Measures to Reduce Vehicle-Miles Traveled

VMT is responsive to various pricing measures, including mileage or other user fees (including fuel taxes), pay-as-you-go insurance, fees for access to road facilities through cordon pricing (tolls paid by motorists to drive in a particular area, such as a city center), and other congestion charges.[92] A third approach involves charging for access to street parking, depending on the time of day and demand, and pricing street spaces to create turnover. This approach reduces VMT two ways: by discouraging unnecessary vehicle trips and by eliminating the need or incentive to circle for an open space.[93]

Policies to Promote a Reduction in Vehicle-Miles Traveled Through Pricing Measures

We discuss three policies to promote a reduction in VMT through pricing measures.

Policy 1: Spur adjustments in the costs of operating a motor vehicle

Policy 2: Encourage variable tolls and congestion pricing

Policy 3: Spur adjustments in the prices for street parking

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91 Research and Innovative Technology Administration Bureau of Transportation Statistics. 2009. *Transportation Statistics Annual Report. U.S. Vehicle-Miles: 1998-2007.* Available at: http://www.bts.gov/publications/transportation_statistics_annual_report/2009/html/chapter_01/table_01_02_10.html [accessed April 21, 2011].

92 Deakin, E., G. Harvey, R. Pozdena, G. Yarema. 1996. *Transportation Pricing Strategies for California: as assessment of congestion, emissions, energy, and equity impacts. Final Report. C*alifornia Air Resources Board. University of California Transportation Center. Available at: http://www.uctc.net/papers/434.pdf [accessed May 19, 2011].

93 Shoup, D. 2005. *The High Cost of Free Parking.* Chicago: American Planning Association Planners Press. Available at: http://www.uctc.net/papers/351.pdf [accessed June 19, 2011]

1.3.2 Impact of Policies: Promote a Reduction in Vehicle-Miles Traveled Through Pricing Measures

Policy 1—Spur adjustments in the costs of operating a motor vehicle

Definition

Measures aimed at increasing the costs of operating a motor vehicle include fuel taxes, pay-as-you-drive insurance, and mileage charges.[94] We discuss congestion pricing and tolls in Policy 2: Encourage variable tolls and congestion pricing.

History of Deployment

Fuel taxes: In 1956 the Highway Revenue Act and the Federal-Aid Highway Act established the Federal Highway Trust Fund, using dedicated revenues from a motor fuel tax, which was set at a fixed amount per gallon. It was last increased in 1993 to 18.4 cents per gallon.[95,96]

Pay-as-you-drive insurance: Starting in late 2010, a number of automobile insurance companies began to offer some version of pay-as-you-drive insurance. Most plans involve using odometer readings to give discounts on future premiums via yearly adjustments. A few use telemetric information to offer discounts more precisely correlated to distance driven.[97]

Mileage pricing: This method has been tested in a small pilot study, but the focus was on the feasibility of the technology and its potential for capturing revenue, more than its effect on VMT.[98]

Effectiveness and Impact on Reducing VMT

Fuel taxes: Gas price increases, which can be a proxy for higher fuel taxes, can reduce VMT by spurring work or residential relocations to shorten or eliminate trips, reducing car ownership, and increasing the use of transit, active transportation, and car-sharing.[99] However, gas price

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94 Atkinson, R.D. 2009. *Paying Our Way: A New Framework for Transportation Finance*. Final Report of the National Surface Transportation Infrastructure Financing Commission. Available at: http://www.itif.org/publications/paying-our-way-new-framework-transportation-finance [accessed June 18, 2011].

95 Ibid.

96 Wachs, M. 2009. After the Motor Fuel Tax: Reshaping Transportation Financing. *Issues in Science and Technology Online*. Available at: http://www.issues.org/25.4/wachs.html [accessed May 19, 2011].

97 The Associated Press. 2011. *Low-Mileage Drivers Benefit from Insurers' Pay-as-You-Drive Plans.* April 11, 2011. Available at: http://wvgazette.com/ap/ApBusiness/201104110175 [accessed May 22, 2011].

98 Hanley, P.S. and J.G. Kuhl. 2011. *National Evaluation of a Mileage-Based Road User Charge: Initial Results.* Presentation at TRB 2011 Annual Meeting. National Academies of Science.

99 Lane, C. 2006. *Effect of Gas Prices on Mode Choice.* Parsons Brinckerhoff Quade & Douglas, Inc. Presentation to the Transportation Research Board Energy Committee. Available at: http://cta.ornl.gov/TRBenergy/trb_documents/LANE-Gas%20Price%20Effect%20on%20Mode%20Choice-1-25-06.pdf [accessed on June 18, 2011]

increases also spur drivers to purchase more fuel-efficient cars, with the result that nearly 60 percent of the reduction in gasoline use comes from more efficient engines, not fewer VMT.[100]

Pay-as-you-drive insurance: It could reduce VMT by a meaningful amount, though there are numerous uncertainties, given the size and heterogeneity of the driving population and driving conditions.[101]

Mileage pricing: More consideration has been given to its effectiveness in generating revenues, with other goals, such as reducing emissions and congestion given secondary consideration.[102] What data there is on VMT reduction is insufficient to conclude its impact, though preliminary study suggests it could encourage switching to alternative modes.[103]

Economic Factors

Fuel taxes: Given the complexity of transportation economics, it is difficult to predict the economic effects of raising fuel taxes. Any increase would have to be substantial to produce a significant reduction in VMT.[104]

Pay-as-you-drive insurance: Pay-as-you-drive insurance is expected to reduce the cost of driving for most drivers. Insurance companies could incur start-up costs outweighing any resulting revenue gains, if they were to install complex, real-time monitoring.[105]

Mileage pricing: Due to the lack of data, there has been no rigorous analysis of the economic effects.[106]

Conclusion

Increasing the cost of operating motor vehicles is likely to reduce VMT, although, given the complexities of economic behavior and tradeoffs involving personal transportation decisions, the scope of the reduction is not fully understood.

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[100] Parry, I.W.H. and K.A. Small. 2005. Does Britain or the United States Have the Right Gasoline Tax? *American Economic Review*, 95 (4): 1276–1289.

[101] Bordoff, J.E. and J.N. Pascal. 2008. *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*. Hamilton Project Discussion Paper. Washington, DC: Brookings Institution. Available at: http://www.brookings.edu/~/media/Files/rc/papers/2008/07_payd_bordoffnoel/07_payd_bordoffnoel.pdf [accessed May 19, 2011].

[102] Sorensen, P., L. Ecola, M. Wachs, M. Donath, L. Munnich, B. Serian. 2011. *Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding.* NCHRP Web-Only Document 143. National Cooperative Highway Research Program. Transportation Research Board. Washington, D.C. Available at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w143.pdf [accessed May 22, 2011].

[103] Whitty, J.M. 2007. *Oregon's Mileage Fee Concept and road User Fee Pilot Program: Final Report.* November 2007. Oregon Department of Transportation. Available at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUFPP_finalreport.pdf?ga=t [accessed May 19, 2011].

[104] Bordoff, J.E. and J.N. Pascal. 2008. *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*, Hamilton Project Discussion Paper. Washington, DC: Brookings Institution. Available at: http://www.brookings.edu/~/media/Files/rc/papers/2008/07_payd_bordoffnoel/07_payd_bordoffnoel.pdf [accessed May 19, 2011].

[105] Ibid.

[106] Ibid.

Policy 2—Encourage variable tolls and congestion pricing

Definition

Variable tolls: Variable tolls can change either in response to actual demand, known as dynamic pricing, or at pre-determined times.[107]

Cordon/congestion pricing: Prices are set at entries, usually based on time of day and level of congestion.[108]

History of Deployment

Variable Tolls: With the advent of automated toll collection, states began converting their free carpool lanes to toll lanes.[109] As of October 2010, there were high occupancy toll lanes (HOT lanes) in the metropolitan areas of San Francisco, Seattle, Miami, Los Angeles, San Diego, Houston, Salt Lake City, Denver, and Minneapolis-St. Paul.

Cordon/congestion pricing: No cordon pricing has been implemented in the U.S. In 2007, New York City proposed the first cordon for a major city, but it was blocked by the state legislature.[110] In San Francisco, a cordon proposal was shelved after negative public reaction, with a final decision not likely until 2013 or 2014.[111] Singapore, London, and Stockholm are the only large cities with cordon pricing schemes.[112]

Effectiveness and Impact

Toll lanes have been found to improve roadway vehicle throughput, increasing the number of vehicles using the system by smoothing out peak demand; it remains unclear whether they can be used to reduce VMT rather than simply shift VMT to less expensive times of day.[113] Cordon

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[107] U.S. Department of Transportation Federal Highway Administration. *Congestion Pricing: A Primer*. Available at: http://ops.fhwa.dot.gov/publications/congestionpricing/sec2.htm [accessed April 14, 2011].

[108] Ibid.

[109] U.S. Department of Transportation Federal Highway Administration. 2010. *Value pricing pilot program.* Available at: http://ops.fhwa.dot.gov/tolling_pricing/value_pricing [accessed November 5, 2010].

[110] Schaller, B. 2010. New York City's Congestion Pricing Experience and Implications for Road Pricing Acceptance in the United States. *Transport Policy*, 17 (2010) 266-273. Available at: http://www.nyc.gov/html/dot/downloads/pdf/schaller_paper_2010trb.pdf [accessed May 19, 2011].

[111] San Francisco County Transportation Authority. 2010. Mobility, Access, and Pricing Study. Available at: http://www.sfcta.org/content/view/302/148 [accessed May 19, 2011].

[112] Schaller, B. 2010. New York City's Congestion Pricing Experience and Implications for Road Pricing Acceptance in the United States. *Transport Policy*, 17 (2010) 266-273. Available at: http://www.nyc.gov/html/dot/downloads/pdf/schaller_paper_2010trb.pdf [accessed May 19, 2011].

[113] Lee, K., A.G. Hobeika, H.B. Zhang and H. Jung. 2010. Travelers' Response to Value Pricing: Application of Departure Time Choices to TRANSIMS. *Journal of Transportation Engineering.* 136, 811 (2010); doi:10.1061/(ASCE)TE.1943-5436.0000139 Available at: http://ascelibrary.org/teo/resource/1/jtpedi/v136/i9/p811_s1?isAuthorized=no [accessed May 22, 2011].

pricing in London reduced private automobile, van, and truck traffic by shifting trips to public transit, bicycles and taxis.[114]

Economic Factors

The economic effects of pricing measures that limit access to transportation facilities through tolls or cordons are not fully understood, given the complexities of transportation economics and the need to factor in social welfare gains and losses.[115]

Conclusion

Cordon pricing has been demonstrated to reduce VMT. Further study is needed to determine whether tolling merely shifts trips to other times of day. The economic effects of either approach are not fully understood.

Policy 3—Spur adjustments in the prices for street parking

Definition

Using programmable meters, and inputs from pavement sensors or other data sources, parking meter rates can be changed dynamically.[116]

History of Deployment

Only a few cities have implemented dynamic parking pricing, and most projects are in their early stages.[117,118,119,120,121]

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[114] Leape, J. 2006. The London Congestion Charge. *Journal of Economic Perspectives*, 20 (4): 157-176. Available at: http://www.jstor.org/stable/30033688?seq=9, p.165 [accessed May 19, 2011].

[115] Viegas, J.M. 2001. Making Urban Road Pricing Acceptable and Effective: Searching for Quality and Equity in Urban Mobility. *Transport Policy*, 8 (4) 289-294.

[116] San Francisco County Transportation Authority. *Value Pricing in San Francisco*. Project Report for the U.S. Department of Transportation. Federal Highway Administration Tolling and Pricing Program. Available at: http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/pubs_reports/projectreports/sfcta_arearoad.htm [accessed May 22, 2011].

[117] Kittelson & Associates. 2008. *Parking Management with Variable Pricing*. December 2008. Available at: http://www.mwcog.org/transportation/activities/tlc/pdf/DDOT-report.pdf [accessed November 15, 2010].

[118] Zack, D. 2005. *The Downtown Redwood City Parking Management Plan*. Available at: http://www.redwoodcity.org/bit/transportation/parking/pdf/DowntownRedwoodCityParkingPlan.pdf [accessed November 15, 2010].

[119] City of Seattle. 2008. *Seattle Urban Mobility Plan: Chapter 7*. January 2008. Available at: http://www.seattle.gov/transportation/docs/ump/07%20SEATTLE%20Best%20Practices%20in%20Transportation%20Demand%20Management.pdf [accessed November 15, 2010].

[120] FHWA. 2009. *Projects Not Involving Tolls: Parking Pricing*. Available at: http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/projects/not_involving_tolls/parking_pricing/index.htm [accessed November 15, 2010].

[121] Performance-Based Parking Pilot Program. District Department of Transportation. Available at: http://ddot.dc.gov/DC/DDOT/On+Your+Street/Traffic+Management/Parking/Performance+Based+Parking+Pilots. [accessed November 15, 2010].

Effectiveness and Impact

Most metered or street parking is not efficiently priced. Availability-based pricing can set prices that insure that sufficient parking spaces are free at any time to eliminate prolonged searches for free spaces, reducing VMT.[122,123] Pricing on-street parking based on availability also reduces VMT by increasing the use of alternative transport modes, and discouraging low-priority vehicle trips.[124]

Economic Factors

The initial cost of installation of parking pricing systems varies depending on the scope of the program, though the operation is revenue-neutral. By reducing demand for new parking spaces, such systems can save money on construction, maintenance, and the like, as well as the opportunity costs associated with foregone land value. Those savings can support reductions in rents or sales prices of properties.[125]

Conclusion

Setting parking prices based on demand and availability, and changing them to maintain an optimum "vacancy rate" is a low-cost or revenue-neutral way to reduce VMT.

1.3.3 Conclusions: Promote a Reduction in Vehicle-Miles Traveled Through Pricing Measures

Pricing measures are a relatively low-cost mechanism for reducing VMT. They target three aspects of motor vehicle transportation: the cost of operating a motor vehicle (fuel prices, insurance prices, and mileage costs); the cost of access to transportation facilities (tolls and cordon charges); and the cost of housing the vehicle at the destination (parking costs).

While increasing the cost of operating motor vehicles is likely to reduce VMT, results are mixed for the individual measures. Fuel taxes would have to increase substantially for any significant reduction. Pay-as-you-drive-insurance and mileage charging schemes would provide incentives to drive fewer miles, but there has been no widespread deployment to test the hypothesis.

Cordon pricing has been demonstrated to reduce VMT, but more study is needed to determine whether tolling merely shifts trips to other times of day or results in absolute reductions. Finally,

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122 Shoup, D. 2005. *The High Cost of Free Parking*. Chicago: American Planning Association Planners Press. Available at: http://www.uctc.net/papers/351.pdf [accessed June 19, 2011].

123 Litman, T. 2011. *Parking Management Strategies, Evaluation and Planning*. Victoria Transport Policy Institute. Available at: http://www.vtpi.org/park_man.pdf [accessed on June 11, 2011].

124 Shoup, D. 2006. Cruising for Parking. *Transport Policy*, 13 (2006) 479-486.

125 Shoup, D. 2005. *The High Cost of Free Parking*. Chicago: American Planning Association Planners Press. Available at: http://www.uctc.net/papers/351.pdf [accessed June 19, 2011].

parking pricing based on availability has resulted in VMT reductions, both in terms of fewer miles driven "cruising" for spaces and fewer discretionary trips.

1.4 Conclusions for Chapter 1

Reducing human exposure to transportation-related emissions that most directly affect human health—carbon monoxide, nitrogen oxide, ozone, (the primary ingredient in smog), particulate matter, sulfur dioxide, and toxics such as lead—can be accomplished through reducing emissions or reducing exposure or both.

Reductions in human exposure can be accomplished by expanding current monitoring systems by focusing on, for example, urban areas with persistently high ozone levels; siting long-term facilities and those that serve vulnerable populations in a way the provides an adequate buffer away from high-pollution sources, with special attention paid to $PM_{2.5}$ exposure; and continuing to build on the success of advanced motor vehicle emission control technologies and fuel efficiency efforts.

The transportation sector's level of greenhouse gas emissions and its contribution to climate change can be reduced by increasing the share of electric vehicles, though there are unknowns about driver behavior, infrastructure investments, and vehicle costs. Another approach is to reduce size disparities among vehicles by reducing their size overall, which can reduce consumer demand for large vehicles and thereby improve fuel economy and decrease transportation-related greenhouse gas emissions. The new CAFE standards that use a size-based indexing system create incentives for carmakers to reduce size disparities in their fleets.

Another method to reduce overall transportation-related emissions is to use pricing measures to reduce vehicle-miles traveled (VMT). These measures address three elements of transportation: the cost of operating a motor vehicle (fuel prices, insurance prices, and mileage costs); the cost of access to transportation facilities (tolls and cordon charges); and the cost of housing the vehicle at the destination (parking costs). Results are mixed for achieving VMT reductions through changing the price of operating costs. Fuel taxes would have to increase substantially for any significant reduction in VMT. Pay-as-you-drive-insurance and mileage charging schemes would provide incentives to drive fewer miles, but there has been no widespread deployment to test the hypothesis. Changing the way access to facilities is priced also shows varying results. Cordon pricing has reduced VMT in some settings. In the case of tolling, more study is needed to determine whether it causes absolute reductions or merely shifts trips to other times of day. Parking pricing has resulted in VMT reductions, both in terms of fewer miles driven "cruising" for spaces and fewer discretionary trips.

Chapter 2. Policies that Enhance Community Design and Promote Active Transportation

2 Introduction: Policies that Enhance Community Design and Promote Active Transportation

Active transportation is self-powered or human-powered transportation that engages people in healthy physical activity while they accomplish the task of traveling from place to place. When an active transportation trip—walking or bicycling—replaces a motor vehicle trip, there is the added benefit of reduced congestion and harmful emissions, and improvements in quality of life.

Physical activity lowers the risk of early death, heart disease, stroke, Type 2 diabetes, high blood pressure, adverse blood lipid profile, metabolic syndrome, and some kinds of cancers. Lack of

physical activity contributes to obesity in conjunction with dietary factors. Remaining physically active can help prevent falls and reduce depression among older adults.[126]

Chapter 2 explores policy changes to encourage greater use of active transportation on a population-level scale, resulting not only in greater physical activity, but also in fewer car trips. We must make active transportation easier, more convenient, and more attractive. One way this can be done is through the creation of new community environments that have: improved connectivity between destinations; infrastructure that encourages walking and bicycling; community design that incorporates the needs of pedestrians and bicyclists as legitimate road users; and strengthened connections between public transit and walking and bicycling. These measures can change the shape and nature of our communities, so that active transportation can become a more attractive choice for all Americans.

Opportunities for Enhancing Community Design and Promoting Active Transportation

Through policies already known, very substantial progress can be made toward enhancing community design and promoting active transportation. We have identified 15 such policies within four areas. The four areas are:

- Provide better connectivity for pedestrians and bicyclists
- Increase investments in infrastructure that supports active transportation
- Consider the needs of all road users in planning and design standards
- Make public transit easier to use for pedestrians and bicyclists.

Provide Better Connectivity for Pedestrians and Bicyclists

Land use, development patterns, and the need for and preference for motor vehicle travel have combined to create community environments in which many Americans rarely walk to a destination, in many cases because they believe that distances are too long.[127]

Among school-aged children in the U.S., the share who walk or bicycle to school has dropped by more than half since 1969,[128] while the share of children traveling to school by car more than tripled, so that, now, half of all children travel to school by car.[129] Distance and community

[126] U.S. Department of Health and Human Services. 2008. *Physical Activity Guidelines for Americans.* Available at: http://www.health.gov/PAGuidelines/Report/Default.aspx [accessed May 2, 2011].

[127] National Household Travel Survey. 2010. NHTS Brief. *Active Travel.* December 2010. Available at: http://nhts.ornl.gov/briefs/ActiveTravel.pdf [accessed May 2, 2011].

[128] Ham, S., S. Martin and H. W. Kohl, III. 2008. Changes in the percentages of students who walk or bike to school—United States, 1969 and 2001. *Journal of Physical Activity and Health, 5* (2): 205-215.

[129] National Household Travel Survey. 2008. NHTS Brief. *Travel to School – The Distance Factor*. January 2008. Available at: http://nhts.ornl.gov/briefs/Travel%20To%20School.pdf [accessed May 19, 2011].

design are factors in these choices. In 1969, a little more than half of students lived within a mile of their schools. By 2001, that was down to 25 percent.[130]

Reducing the size of street blocks, locating key community destinations in closer proximity to home and work, and providing incentives to develop land in dense, mixed-use patterns will enhance community design and support active transportation.

Increase Investments in Infrastructure that Supports Active Transportation

In recent years, federal transportation policy has begun a more concerted investment in infrastructure that makes active transportation easier. Facilities include sidewalks, multi-use trails, bicycle lanes and paths, pedestrian crossing improvements, and street designs that narrow roadways and reduce traffic speed.

Expanding the existing Safe Routes to School national program and encouraging development of an investment in Complete Streets design will provide support for active transportation infrastructure investments. Additionally, encouraging development of bicycle boulevards—a way to integrate bicycle transportation into the street network while maintaining safety—and encouraging more signage aimed at pedestrians and bicyclists will make community design more conducive to active transportation.

Consider the Needs of All Road Users in Planning and Design Standards

Transportation projects have historically placed the highest priority on achieving efficiencies for motor vehicles, coming at the cost of safety and comfort for pedestrians and bicyclists, and having the effect of reducing the practicality and comfort of active travel.

Incorporating active transportation users' needs into transportation planning and design can be accomplished by setting goals for pedestrian and bicycle levels of service in any project, and encouraging route analysis to include pedestrian and bicycle access. Finally, adjusting vehicle design standards to incorporate elements that are more forgiving to pedestrians and bicyclists in the event of crashes would make walking—and bicycling—safer.

Make Public Transit Easier to Use for Pedestrians and Bicyclists

A recurring obstacle to transit use is the so-called last/first mile problem, which refers to barriers transit users experience in either reaching a transit facility to start their journey, or completing the final leg that brings them to their destination. Walking and bicycling are modes that are suited for

[130] McDonald, N. 2007. Children's Mode Choice for the School Trip: The Role of Distance and School Locations in Walking to School. *Transportation*, 35 (1): 23-35.

short trips. While federal support for transit has increased over the past decade or so, there has been little effort to coordinate pedestrian and bicycle facilities with transit spending.[131]

Public transit can be made easier for pedestrians and bicyclists to use by making ample room for bicycles on trains and buses, making transit stops and stations more accessible by foot and bicycle, providing route maps and other information about routes and schedules, and by fostering transit-oriented development.

Chapter 2 at a Glance

In this chapter we will examine four policies that could enhance community design in order to promote active transportation. They are:

2.1 Provide Better Connectivity for Pedestrians and Bicyclists

2.2 Increase Investments in Infrastructure that Supports Active Transportation

2.3 Consider the Needs of All Road Users in Planning and Design Standards

2.4 Make Public Transit Easier to Use for Pedestrians and Bicyclists

[131] Schneider, R. 2005. *TCRP Synthesis 62: Integration of bicycles and transit.* Transportation Research Board: Washington, D.C. Available at: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_62.pdf [accessed on June 19, 2011]

2.1 Provide Better Connectivity for Pedestrians and Bicyclists

2.1.1 Background: Provide Better Connectivity for Pedestrians and Bicyclists

Definition

Connectivity is defined as how often streets or roadways intersect, or how closely intersections are spaced. Grid-like street patterns usually have greater connectivity than those with curving streets and cul-de-sacs.[132]

Current Status

"Context-sensitive design/solutions" and "Complete Streets" are the two most widely used approaches that incorporate connectivity. Context-sensitive design incorporates elements such as livability, sense of place, human-scaled urban design, and environmental protection into transportation projects without sacrificing traditional objectives of safety, efficiency, capacity, and maintenance.[133,134] Complete streets explicitly includes the needs of all road users in road design and planning, and specifically sets connectivity as one of the goals for all projects.[135]

History

Initially, older cities were laid out in shorter blocks in a grid-like pattern that enhances connectivity. This changed in the middle of the 20th Century as freeways were built through urban areas, and suburban land was developed at considerably lower densities. Cities were laid out with street designs employing longer blocks, and suburbs had frequent cul-de-sacs.[136] Additionally, communities were more spread out, and key destinations were located far apart.[137,138]

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[132] Turley, B. M. 2008. *Mobilizing Connectivity: Applying Connectivity Tools in the Arterial Planning Process.* Presented at the 11th National Conference on Transportation Planning for Small and Medium-Sized Communities. Transportation Research Board and Federal Highway Administration. Available at: http://pubsindex.trb.org/view.aspx?id=899091 [accessed on June 19, 2011].

[133] NCHRP REPORT 480. 2002 *A Guide to Best Practices for Achieving Context Sensitive Solutions.* Available at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_480.pdf [accessed May 2, 2011].

[134] Hasson, P., Bradley, S., Walvatne, P., Lutkevich, P., C. Leone. 2009. Trees, Lighting, and Safety in Context-Sensitive Solutions. *Transportation Research Record: Journal of the Transportation Research Board:* 101-111.

[135] National Complete Streets Coalition. *FAQ.* Available at: http://www.completestreets.org/complete-streets-fundamentals/complete-streets-faq/ [accessed September 29, 2010].

[136] Saelens, B.E. and S.L. Handy. 2008. Built Environment Correlates of Walking: A Review. *Medicine in Science and Sports and Exercise*, 40 (7): S550-S556.

[137] Kochtitzky, C.S., H. Frumkin, R. Rodriguez, A.L. Dannenberg, J. Rayman, K. Rose, R. Gillig and T. Kanter. 2006. Urban Planning and Public Health at CDC. *Morbidity and Mortality Weekly Report* 55 (SUP02): 34-38. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/su5502a12.htm [accessed October 2010].

[138] Centers for Disease Control and Prevention. 2010. *Healthy Places: About Healthy Places.* National Center for Environmental Health. Available at: http://www.cdc.gov/healthyplaces/about.htm [accessed October, 2010].

Potential to Support Increased Active Transportation

Disconnected or extended-scale street patterns make traveling between locations less direct and less convenient for pedestrians and bicyclists. When long distances separate destinations, or when land use is sprawling rather than compact and mixed, active transportation is not an attractive choice.[139]

High levels of street connectivity are positively associated with active transportation levels.[140,141] Active transportation also increases when there is sufficient residential density and land use mixes.[142]

Policies for Better Connectivity for Pedestrians and Bicyclists

Policy 1: Encourage block size limits that are conducive to walking

Policy 2: Encourage appropriate location of key community destinations to increase active transportation

Policy 3: Incentivize land use patterns that are conducive to active transportation

2.1.2 Impact of Policies: Provide Better Connectivity for Pedestrians and Bicyclists

Policy 1—Encourage block size limits that are conducive to walking

Definition

A block is an area of land, usually as a square or polygon, surrounded by streets or roads. Block size, the area of a given block, is highly variable. Blocks in older U.S. cities typically are less than 500 feet long on a side.[143]

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139 Harkey D.C. and C.V. Zegeer. 2004. *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System.* FHWA. Available at: http://www.walkinginfo.org/training/collateral/resources/PEDSAFEGuide.pdf [accessed on June 19, 2011].

140 Wesley, M. and N. Garrick, 2010. *The Effect of Street Network Design on Walking and Biking.* Presented at the Transportation Research Board Annual Meeting. National Academies of Science. Available at: http://www.sacog.org/complete-streets/toolkit/files/docs/Garrick%20&%20Marshall_The%20Effect%20of%20Street%20Network%20Deisgn%20on%20Walking%20and%20Biking.pdf [accessed on June 19, 2011].

141 Oakes, J.M., A. Forsyth, K.H. Schmitz and M. Hearst. 2007. The Effects of Neighborhood Density and Street Connectivity on Walking Behavior: the Twin Cities Walking Study. *Epidemiologic Perspectives & Innovations*, 4 (16): 1-9.

142 Berrigan, D., L.W. Pickle and J. Dill. 2010. Associations Between Street Connectivity and Active Transportation. *International Journal of Health Geographics*, 9: 20.

143 Ewing, R., T. Schmid, R. Killingsworth, A. Zlot and S. Raudenbush. 2008. Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity. *American Journal of Public Health Promotion*, 18 (1): 47-57.

History

In the mid-20th Century, many American downtowns were restructured and rebuilt. Block size was often enlarged in these newer sections, and street networks were re-aligned to serve higher-speed traffic and feed the highways that were being built.[144,145] In suburbs, a favored street design was a curving uninterrupted street, often ending in a cul-de-sac. These designs resulted in a decrease of neighborhood connectivity.

Effectiveness and Impact

Residents of neighborhoods with shorter block lengths are more likely to walk to their destinations,[146] along with other neighborhood factors, such as land use density and mix of commercial uses.[147,148]

Economic Factors

Neighborhood connectivity may enhance an area's "social capital," as neighborhoods with walkable, mixed-use designs have stronger social networks and interactions than neighborhoods that are car-dependent.[149] Health care cost savings also result from improving connectivity and increasing walking.[150]

Conclusion

Reducing block size can help create a community that is more accessible to pedestrians and bicyclists and thus encourages more walking and bicycling, with an accompanying increase in physical activity and fitness levels.

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144 Ryan, B.D. 2008. The Restructuring of Detroit: City Block Form Change in a Shrinking City, 1900-2000. *Urban Design International*, 13 (3): 1-13.

145 Reilly, M. and J. Landis. 2002. *The Influence of Built-Form and Land Use on Mode Choice: Evidence from the 1996 Bay Area Travel Survey.* Institute of Urban and Regional Development Working Paper. IURD WP 2002-4. Available at: http://www.uctc.net/papers/669.pdf [accessed on June 19, 2011].

146 Boer, R., Y. Zheng, A. Overton, G.K. Ridgeway and D.A. Cohen. 2007. Neighborhood Design and Walking Trips in Ten U.S. Metropolitan Areas. *American Journal of Preventive Medicine*, 32 (4): 298-304.

147 Berrigan, D., Pickle, L.W., J. Dill. 2010. Associations Between Street Connectivity and Active Transportation. *International Journal of Health Geographics*, 9 (1): 20.

148 Ewing, R., T. Schmid, R. Killingsworth, A. Zlot and S. Raudenbush. 2008. Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity. *American Journal of Public Health Promotion*, 18 (1): 47-57.

149 Leyden, K.M. 2003. Social Capital and the Built Environment: The Importance of Walkable Neighborhoods. *American Journal of Public Health*, 93: 1546-1551.

150 American Public Health Association. 2010. *Backgrounder: The Hidden Health Costs of Transportation.* Available at: http://trid.trb.org/view.aspx?id=919815 [accessed on June 16, 2011].

Policy 2—Encourage appropriate location of key community destinations to increase connectivity for pedestrians and bicyclists

Definition

A community design where key destinations are located to enhance connectivity for pedestrians and bicyclists is characterized by compact and highly mixed land use.[151]

History

Aligning facilities planning with pedestrian and bicycle connectivity has not taken place to any significant degree in the past.[152] Recently, federal transportation policies have encouraged state and regional transportation plans to integrate more compact development and land use that is amenable to walking and bicycling.[153]

Effectiveness and Impact

Locating key destinations close to the populations they serve is associated with a high degree of walking as a regular transport mode. Increasing the mix of utilitarian destinations in neighborhoods encourages inactive individuals to make purpose-driven walking trips and encourages higher levels of active travel among already-active individuals.[154] This pertains to home-school trips as well.[155] In addition, higher residential density and greater amounts of accessible retail floor area are associated with higher rates of walking.[156,157]

Economic Factors

Higher-density, compact development results in societal savings from a reduced need for infrastructure investments by encouraging development in existing communities. There are also savings related to reduced transportation-related energy use, emissions, and congestion. Households and individuals realize benefits through reduced fuel purchases and other transportation-related expenses, which, together with housing, account for 50 cents of every

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151 Cervero, R. and K. Kockelman. 1997. Travel Demand and the Three Ds: Density, Diversity, and Design. Transportation Research Part D: *Transport and Environment*, 2 (2): 199–219.

152 Steiner, R.L., Crider, L.B., M. Betancourt. 2006. *Safe Ways to School—the Role in Multimodal Planning.* Florida Department of Transportation Systems Planning Office. Tallahassee, Florida. DOT F 1700.7 (8-72) Available at: http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PL/FDOT_BD545_32_rpt.pdf [accessed on June 19, 2011].

153 U.S. Government Code of Federal Regulations. *Title 23: Highways. Part 450—Planning Assistance and Standards*. Available at: http://tinyurl.com/4y2xsg7 [accessed May 5, 2011].

154 McCormack, G.R., B. Giles-Corti and M. Bulsara, 2008. The Relationship Between Destination Proximity, Destination Mix and Physical Activity Behaviors. *Preventive Medicine*, 46 (1): 33-40.

155 Yang, Y., M. Schlossberg, R. Parker and B. Johnson. 2010. *Understanding School Travel: How Location Choice and the Built Environment Affect Trips to School.* Oregon Transportation Research and Education Consortium. Portland, Oregon. OTREC-RR-10-01. Available at: http://ipri.uoregon.edu/index.cfm?mode=research&page=projects [accessed on June 19, 2011].

156 Marshall, J.D., M. Brauer and L.D. Frank. 2009. Healthy Neighborhoods: Walkability and Air Pollution. *Environmental Health Perspectives*, 117 (11): 1752-1759.

157 Cervero, R. and M. Duncan. 2003. Walking, Bicycling, and Urban Landscape: Evidence from the San Francisco Bay Area. *American Journal of Public Health*, 93: 1478-1483.

dollar earned, on average.[158] From a governmental perspective, more compact land use generates higher revenues per acre of developed land.[159]

Conclusion

Locating key destinations in a way that creates dense land use with a high degree of mixed land use increases connectivity for pedestrians and bicyclists.

Policy 3—Incentivize land use patterns that are conducive to connectivity for pedestrians and bicyclists

Definition

A number of mechanisms that have been developed to affect land use decisions—tax incentives, expedited permits, fee or regulatory relief—can be utilized to create incentives for dense, highly mixed land use.[160,161,162,163]

History

Policies to encourage denser mixed-use development have proliferated in the past few years, with states and cities passing measures requiring denser development.[164,165]

Effectiveness and Impact

There are few systematic tests of the effectiveness of policies aimed at encouraging dense, mixed land use, largely because they are still being developed or have been deployed only recently.[166]

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158 Kooshin, C. and S. Winkelman. 2011. *Growing Wealthier, Smart Growth, Climate Change and Prosperity.* Center for Clean Air Policy. Available at: http://tinyurl.com/43cn736 [accessed May 4, 2011].

159 Calthorpe Associates. 2011. *Vision California: Charting Our Future.* Statewide Scenarios Report. March 2011. Available at: http://tinyurl.com/5v92edg [accessed May 5, 2011].

160 Freilich, R.H., N.M. Popowitz. 2010. The Umbrella of Sustainability: Smart Growth, New Urbanism, Renewable Energy and Green Development in the 21st Century. *The Urban Lawyer. Environmental Studies and Policy Collection,* 42 (1): 1-39.

161 U.S. Department of Housing and Urban Development. *Sustainable Housing and Communities.* Available at: http://portal.hud.gov/hudportal/HUD?src=/program_offices/sustainable_housing_communities [accessed March 12, 2011].

162 Salkin, P. and A. Lavine. 2008. Land Use Law and Active Living: Opportunities for States to Assume a Leadership Role in Promoting and Incentivizing Local Options. *Rutgers Journal of Law and Urban Policy*, 5.

163 Frank, L. and S. Kagave. 2009. A National Plan for Physical Activity: Enabling Role of the Built Environment. *Journal of Physical Activity and Health,* 6 (Suppl 2): S186-S195.

164 Nolon, J.R. 2009. The Land Use Stabilization Wedge Strategy: Shifting Ground to Mitigate Climate Change. *William & Mary Environmental Law and Policy Review,* 34: 1.

165 Litman, T. 2009. *Quantifying the Benefits of Nonmotorized Transportation for Achieving Mobility Management Objectives.* Victoria Transport Policy Institute.

166 Nolan, J.R. 2008. *Shifting Ground to Address Climate Change: the Land Use Law Solution.* Pace Law Faculty Publications. Available at: http://www.law.pace.edu/files/landuse/Shifting_Ground_Penultimate.pdf [accessed June 21, 2011]

Economic Factors

Specific total cost estimates of these programs, including subsidies for land use changes, are unknown. Costs would include delayed opening of buildings and higher land prices in areas that are accessible by pedestrians and cyclists. Benefits would include potential savings in pollution, congestion, and reduced needs for infrastructure and land.[167,168]

Conclusion

Utilizing mechanisms that are already in place create incentives for dense, mixed-use developments would result in land use patterns that have greater connectivity for pedestrians and bicyclists and that make walking and bicycling more attractive.

2.1.3 Conclusions: Provide Better Connectivity for Pedestrians and Bicyclists

Increasing connectivity for pedestrians and bicyclists makes walking and bicycling more attractive choices, enabling people to increase their trips by these modes. This should increase the health benefits associated with greater levels of physical activity and reduce the costs and negative impacts associated with motor vehicle travel.

There are three distinct policies reviewed in this section, and each can be an effective tool for increasing connectivity. Reducing block size makes destinations more accessible to pedestrians and bicycles, as do policies that encourage key destinations to be located closer together. Lastly, incentives to create dense, highly mixed land use complement market forces that recognize the lowered costs and increased benefits of more compact development.

2.2 Increase Investments in Infrastructure that Supports Active Transportation

2.2.1 Background: Increase Investments in Infrastructure that Supports Active Transportation

Definition

Infrastructure that supports active transportation includes: sidewalks, multi-use trails, bicycle lanes and paths, cycle tracks, bicycle boulevards (designated low-volume streets, usually

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167 Calthorpe Associates. 2011. *Vision California: Charting Our Future.* Statewide Scenarios Report. March 2011. Available at: http://tinyurl.com/5v92edg [accessed May 5, 2011].

168 Barkalow, G. and G. Bernis. 2007. *The Role of Land Use in Meeting California's Energy and Climate Change Goals.* California Energy Commission: Draft Staff Paper, 2007: 2. Available at: http://www.energy.ca.gov/2007publications/CEC-600-2007-008/CEC-600-2007-008-SD.PDF [accessed on June 21, 2011].

connected to form a network), pedestrian crossings, pedestrian/bicycle bridges, paved shoulders, striped bicycle lanes, pedestrian signals, bicycle-actuated signals, medians and other pedestrian "refuges," high-visibility crosswalk striping, raised pedestrian crossings, in-pavement lighting, overhead illuminated crosswalks, recessed stop lines, warning signs, and street designs that narrow roadways and reduce traffic speed such as sidewalk extensions and other structures.[169,170,171]

Current Status

In recent years, pedestrian and bicycle infrastructure has received more funding in absolute terms ($1.04 billion in 2010), but remains a small percentage (2 percent) of the federal surface transportation budget.[172] DOT Secretary Ray LaHood announced a new policy statement in March of 2010 on bicycle and pedestrian accommodation that expands the federal commitment to pedestrian and bicycle infrastructure.[173]

History

Federal support for pedestrian and bicycle infrastructure has risen significantly in the past 20 years. Starting with the Intermodal Surface Transportation Efficiency Act (ISTEA), federal funding for pedestrian and bicycle infrastructure reached meaningful levels, approximately $150 million a year from 1992 to 1998. With the Transportation Equity Act for the 21st Century (TEA21), that increased to an average of $360 million per year from 1999 to 2005. Under the Safe, Accountable, Flexible, Efficient, Transportation Equity Act (SAFETEA-LU) it rose dramatically to nearly $1 billion a year from 2006 to 2009.[174]

Programs that fund pedestrian and bicycle infrastructure include the Surface Transportation Program Safety Set-Aside for Transportation Enhancement Activities, the Highway Safety Improvement Programs, the Congestion Mitigation and Air Quality Improvement Program, the

169 U.S. Department of Transportation Federal Highway Administration. 2011. *Bicycle Facilities and the Manual on Uniform Traffic Control Devices.* Available at: http://www.fhwa.dot.gov/environment/bikeped/mutcd_bike.htm. [accessed May 6, 2011].

170 U.S. Department of Transportation Federal Highway Administration. *Selecting Pedestrian Safety Improvements* (Crash Types/Countermeasure Matrix). Available at: http://safety.fhwa.dot.gov/saferjourney/library/matrix.htm [accessed May 6, 2011].

171 U.S. Department of Transportation Federal Highway Administration. 2010. *Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations.* Available at: http://www.fhwa.dot.gov/environment/bikeped/policy_accom.htm [accessed October 5, 2010].

172 U.S. Department of Transportation Federal Highway Administration. 2009. *Federal-Aid Highway Program Funding for Pedestrian and Bicycle Facilities and Programs.* Available at: http://www.fhwa.dot.gov/environment/bikeped/bipedfund.htm [accessed March 12, 2011].

173 U.S. Department of Transportation Federal Highway Administration. 2010. *Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations.* Available at: http://www.fhwa.dot.gov/environment/bikeped/policy_accom.htm [accessed May 9, 2011].

174 Pucher, J., R. Buehler and M. Seinen. 2011. Bicycling Renaissance in North America? An Update and Re-Appraisal of Cycling Trends and Policies. *Transporation Research Part A: Policy and Practice*, 45 (6): 451-47.

Safe Routes to School program, the Non-Motorized Transportation Pilot Program, and the Recreational Trail Program.[175]

Potential to Increase Active Transportation

Investing in pedestrian and bicycle infrastructure has been shown to result in increases in walking and bicycling. Infrastructure investments are considered more successful in increasing active transportation when combined with a comprehensive package of complementary policies.[176]

Policies to Increase Investments in Infrastructure that Supports Active Transportation

Policy 1: Encourage investment in Complete Streets

Policy 2: Strengthen Safe Routes to School programs

Policy 3: Encourage use of street design and facilities that increase pedestrians and bicyclists' safety and comfort levels

Policy 4: Encourage bicycle boulevards

Policy 5: Encourage use of signage, maps, and other wayfinding methods for pedestrians and bicyclists

2.2.2 Impact of Policies: Increase Investments in Infrastructure that Supports Active Transportation

Policy 1—Encourage investment in Complete Streets

Definition

Complete Streets is an engineering and design approach that actively considers the needs of all road users—pedestrians, bicyclists, motorists, and transit riders—of all ages and abilities, and gives priority to street connectivity and context-sensitive designs, while measuring results.[177]

History

On March 15, 2010, the Obama administration issued formal guidance on Complete Streets concepts for state and regional transportation departments, including recommendations that states

[175] Federal Highway Administration. 2009. Federal-Aid Highway Program Funding for Pedestrian and Bicycle Facilities and Programs. Available at: http://www.fhwa.dot.gov/environment/bikeped/bipedfund.htm [accessed October 5, 2010].

[176] Pucker, J., J. Dill and S. Handy. 2009. Infrastructure, Programs, and Policies to Increase Bicycling: An International Review. *Preventive Medicine* 50 (2010): S106–S125.

[177] National Complete Streets Coalition. *FAQ.* Available at: http://www.completestreets.org/complete-streets-fundamentals/complete-streets-faq/ [accessed September 29, 2010].

collect data on walking and bicycling trips, find ways to improve bike paths and sidewalks during maintenance projects, and ensure children and the elderly have adequate transportation choices.[178] As of March 2011, more than 23 states and 140 local governments had adopted Complete Streets policies.[179]

Effectiveness and Impact

Enhancing pedestrian and bicycle infrastructure environment can cause people to walk and bicycle more[180,181,182,183,184] and can also improve automobile safety.[185]

Economic Factors

Interventions that make streets more comfortable and safer for all users add little overall to the cost of a typical street improvement project and can yield a high rate of return in terms of public health, economy and environmental benefits from reducing emissions, congestion, and energy use and encouraging more active travel.[186,187,188]

Conclusion

The Complete Streets concept is being adopted by a growing number of localities and is receiving the backing of the federal government. Earlier pedestrian and bicycle infrastructure improvements similar to what are proposed in Complete Streets have resulted in increased levels of walking and bicycling and have enhanced safety for all road users while performing within accepted cost-

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178 Federal Highway Administration. 2010. United States Department of Transportation. *Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations.* Available at: http://www.fhwa.dot.gov/environment/bikeped/policy_accom.htm [accessed May 9, 2011].

179 National Complete Streets Coalition. *Complete Streets Atlas.* Available at: http://www.completestreets.org/complete-streets-fundamentals/complete-streets-atlas/ [accessed October 5, 2010].

180 Saelens, B.E. and S.L. Handy. 2008. Built Environment Correlates of Walking: A Review. *Medicine and Science in Sports and Exercise*, 40 (7SL): S550-S566.

181 Ewing, R. and R. Cervero. 2010. Travel and the Built Environment: A Meta-Analysis. *Journal of the American Planning Association*, 76 (3): 265-294.

182 The Community Guide to Preventive Services: *Promoting Physical Activity: Environmental Approaches*. Available at: http://www.thecommunityguide.org/pa/environmental-policy/index.html [accessed February 2, 2011].

183 Pucher, J.; Dill, J. and S. Handy. 2010. Infrastructure, Programs, and Policies to Increase Bicycling: An International Review. *Preventive Medicine*, 50 (1): S106-S125.

184 Staunton, C.E., D. Hubsmith and W. Kallins. 2003. Promoting Safe Walking and Biking to School: The Marin County Success Story. *American Journal of Public Health*, 93 (9): 1431-1434.

185 Heath, G.W., R.C. Brownson, J. Kruger, R. Miles, K.E. Powell, L.T. Ramsey, and the Task Force on Community Preventive Services. 2006. The Effectiveness of Urban Design and Land Use and Transport Policies and Practices to Increase Physical Activity: A Systematic Review. *Journal of Physical Activity and Health*, 3 (1): S55-S76.

186 Woodcock, J., et al. 2009. Public health benefits of strategies to reduce greenhouse-gas emissions: Urban land transport. *The Lancet*. 374:1930-1943.

187 Minnesota Department of Transportation. 2009. *Complete Streets Final Report.* Available at: http://www.dot.state.mn.us/planning/completestreets/legislation.html [accessed September 24, 2010].

188 *Benefit-Cost Analysis of Bicycle Facilities.* National Cooperative Highway Research Program, Minnesota Department of Transportation, Midwest Regional University Transportation Center. Available at: http://www.bicyclinginfo.org/bikecost/index.cfm [accessed February 2, 2011].

benefit parameters. This supports the value of a dedicated funding program devoted to Complete Streets, as well as additional investment in permanent, long-term performance measures and other types of accountability systems.

Policy 2—Strengthen Safe Routes to School programs and improve infrastructure

Definition

Safe Routes to School (SRTS) employs a combination of evaluation (surveying parents to find out why children are being driven to school), engineering (new signals, crosswalks, sidewalks), education (school-based safety programs), encouragement (activities involving parents and children to encourage walking and bicycling), and enforcement (speed enforcement, yielding in crosswalks, etc.) to improve the safety of the physical environment surrounding schools and encourage children to walk and bicycle to school.

History

Congress established the SRTS program in 2005 to address the fact that the number of children walking or bicycling to school had fallen steeply and to encourage active travel to school by improving safety along the routes. As of 2010, schools in all 50 states and the District of Columbia had implemented SRTS programs.[189]

Effectiveness and Impact

Perceived traffic safety threats have been cited as an important factor when parents choose whether their children will walk or bicycle to school rather than travel to school by car.[190] Walking and bicycling increases at schools with SRTS programs,[191,192] and SRTS infrastructure improvements create safety benefits for all road users.[193]

Economic Factors

The long-term benefits of increased physically active travel—including most notably reductions in childhood obesity, greenhouse gas emissions, pollution, congestion, and traffic injuries—

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189 National Center for Safe Routes to School. 2010. *2010 SRTS Program Tracking Brief*. Available at: www.saferoutesinfo.org/sites/default/files/Fall%20**2010**.pdf [accessed October 3, 2010].

190 Carver, A., A. Timperio and D. Crawford. 2008. Playing it safe: The Influence of Neighbourhood Safety on Children's Physical Activity—A Review. *Health & Place*, 14 (2): 217-227.

191 Boarnet, M.G., K. Day, C. Anderson, T. McMillan and M. Alfonzo. 2005. California's Safe Routes to School Program: Impacts on Walking, Bicycling, and Pedestrian Safety. *Journal of the American Planning Association*, 71 (3): 301-317.

192 Orenstein, M.R., N. Gutierrez, T.M. Rice, J.F. Cooper and D.R. Ragland. 2007. *Safe Routes to School: Safety and Mobility Analysis.* Report to California Legislature. Available at: http://escholarship.org/uc/item/5455454c [accessed June 21, 2011].

193 Watson, M. and A.L. Dannenberg. 2008. Investment in Safe Routes to School Projects: Public Health Benefits for the Larger Community. *Preventing Chronic Disease: Public Health Research, Practice and Policy*, 5 (3): 1-7.

would suggest that SRTS produces a net benefit, but these benefits have not been quantified in direct association with SRTS.[194]

Conclusion

SRTS appears to lead to a decline in pedestrian injury and an increase in walking and bicycling, among a key population—school children—that is experiencing a sharp decline in physical activity. The large demand for project funds suggests that there is considerable local support and enthusiasm for SRTS.

Policy 3—Encourage use of street design and facilities that increase pedestrians' and bicyclists' safety and comfort levels

Definition

Design that increases pedestrians' and bicyclists' sense of safety and comfort creates a sense of security and separation from traffic by the use of lighting, sidewalk layout, bike lanes and paths, sidewalk furniture, street trees, protected crossings, and medians.[195,196,197,198]

History

The 1998 Transportation Equity Act for the Twenty-first Century (TEA21) and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) of 2005[199] have included efforts to promote designs that answer pedestrian and bicyclist needs. The 2010 federal statement endorsing Complete Streets has added more support.[200]

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194 General Accountability Office. 2008. *Safe Routes to School. Progress in Implementing the Program, but a Comprehensive Plan to Evaluate Program Outcome is Needed.* July 2008. GAO-08-789. Available at: http://www.gao.gov/new.items/d08789.pdf [accessed October 5, 2010].

195 Gandhi, T. and M.M. Trivedi. 2007. Pedestrian Protection Systems: Issues, Survey, and Challenges. *IEE Transactions on Intelligent Transportation Systems,* 8 (3).

196 American Association of State Highway and Transportation Officials. 2010 *AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities.*

197 Centers for Disease Control and Prevention. 2010. *Healthy Community Design*. Available at: http://www.cdc.gov/Features/HealthyCommunities/ [accessed October, 2010].

198 National Association of City Transportation Officials. 2011. *NACTO Urban Bikeway Design Guide*. 2011. Available at: http://www.apbp.org/news/62832/NACTO-Urban-Bikeway-Design-Guide.htm [accessed on June 21, 2011].

199 U.S. Department of Transportation Federal Highway Administration. 2005. *A Summary Of Highway Provisions in SAFETEA-LU*. Available at: http://www.fhwa.dot.gov/safetealu/summary.htm [accessed October, 2010].

200 U.S. Department of Transportation Federal Highway Administration. 2010. *Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations.* Available at: http://www.fhwa.dot.gov/environment/bikeped/policy_accom.htm [accessed October 5, 2010].

Effectiveness and Impact

Examining a few elements of this package of design approaches suggests there are beneficial effects. Adequate lighting is a top facilitator for walking.[201] Continuous bike lanes or trails are some of the top facilitators for cycling[202] and give pedestrians a buffer from traffic.[203] Bicyclists choose routes based on bicycle facilities rather than travel distance.[204]

Economic Factors

Pedestrian and bicyclist improvements increase property values in some settings.[205] There is emerging evidence that pedestrian and bicycle infrastructure is cost effective.[206]

Conclusion

Designs that increase pedestrians' and bicyclists' sense of security and safety enhance the overall street environment and promote walking and bicycling without substantial added costs.

Policy 4—Encourage bicycle boulevards

Definition

A bicycle boulevard usually runs parallel to busier streets, providing bicyclists with a lower-speed, alternate route to popular destinations.[207]

History

Bicycle boulevards are a relatively new concept in the U.S., although the first ones were implemented in the 70s in Berkeley[208] and Palo Alto and, more recently, in Portland, Oregon. Cities in New Mexico and South Carolina have also recently installed them.[209,210]

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201 Hasson, P., S. Bradley, P. Walvatne, P. Lutkevich and C. Leone. 2009. Trees, Lighting, and Safety in Context-Sensitive Solutions. *Transportation Research Record: Journal of the Transportation Research Board*, 101-111.

202 Lee, C. and A.V. Moudon. 2008. Neighborhood Design and Physical Activity. *Building Research and Information*, 36 (5): 395-411.

203 American Association of State Highway and Transportation Officials. 2010 *AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities*.

204 Winters, M., K. Teschke, M. Grant, E.M. Selton and M. Brauer. 2010. How Far Out of the Way Will We Travel? Built Environment Influences on Route Selection for Bicycle and Car Travel. *Transportation Research Record: Journal of the Transportation Board.*

205 Snyder, R. *The Economic Value of Active Transportation: A Fact Sheet.* Ryan Snyder Associates. Available at: http://www.rsa.cc/images/EconomicValueOfActiveTransportation.pdf [accessed May 19, 2011].

206 Gotschi, T. 2011. Costs and Benefits of Bicycling Investments in Portland, Oregon. *Journal of Physical Activity and Health* 8 (Suppl 1): S49.

207 Dill, J. 2009. Bicycling for Transportation and Health: The Role of Infrastructure. *Journal of Public Health Policy* 30: S95–S110.

208 DeRobertis, M. 2001. *Berkeley's Bicycle Boulevard Network.* ITE Annual Meeting.

209 Alliance for Bicycling and Walking. 2010. *Bicycling and Walking in the United States 2010 Benchmarking Report*. Washington, DC. Available at: http://green-changemakers.blogspot.com/2010/02/alliance-for-biking-and-walking-2010.html [accessed on June 21, 2011]

Effectiveness and Impact

Bicyclists go out of their way to use bicycle boulevards,[211] which can provide a feeling of security.[212] They are most effective at encouraging bicycling when they provide continuity over the two- to-five-mile distance of an average urban bicycle trip.[213]

Economic Factors

Costs include implementation and maintenance.[214,215]

Conclusion

Bicycle boulevards encourage bicycle travel.

Policy 5—Encourage use of signage, maps, and other wayfinding methods for pedestrians and bicyclists

Definition

Wayfinding devices include signs, maps, landscape cues,[216] and pavement or sidewalk markings.[217] There are also online tools for wayfinding via GPS-enabled cell phones[218] and Web sites.[219]

History

The term "wayfinding" was first used in 1960 by the architect Kevin Lynch in his book, *The Image of the City.*[220] In the transportation context, wayfinding was first developed with an

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[210] Pucher, J., J. Dill and S. Handy. 2010. Infrastructure, Programs, and Policies to Increase Bicycling: An International Review. *Preventive Medicine* 50 (2010) S106-S125.

[211] Ibid.

[212] Dill, J. and T. Carr. 2007. *Bicycle Commuting and Facilities in Major U.S. Cities: If You Build Them, Commuters Will Use Them.* Transportation Research Board Record 1828. 2007. Paper No. 03-4134.

[213] American Association of State Highway and Transportation Officials. 2010. *AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities.*

[214] Ibid.

[215] Walker, L. 2009. *Fundamentals of Bicycle Boulevard Planning and Design, Initiative for Bicycle and Pedestrian Innovation.* Center for Transportation Studies. Portland, Oregon.

[216] Kaplan, R. 1983. *The role of nature in the urban context.* In: Altham I. and J. Wohlwill, Eds. Behavior and the Natural Environment. New York: Plenum.

[217] U.S. Department of Transportation Federal Highway Administration. *Pedestrian Crossings.* Available at: http://www.fhwa.dot.gov/environment/sidewalk2/sidewalks208.htm [accessed June 29, 2011].

[218] Young, M., N. Stanton, G. Walker, D. Jenkins and W. Smart. 2008. Where do we go from here? An assessment of navigation performance using a compass versus a GPS unit. *Cogn Tech Work* (2008) 10:231–236. Available at: http://www.springerlink.com/content/r35420t5044p6627/fulltext.html [accessed October 10, 2010].

[219] Helft, M. Google Maps Adds Directions for Cyclists. *New York Times*. March 9, 2010. Available at: http://gadgetwise.blogs.nytimes.com/2010/03/09/google-maps-adds-directions-for-cylists/ [accessed October 11, 2010].

[220] Reeder, L. Wayfinding. *The American Institute of Architects. Architect's Knowledge Resource*. Available at http://www.aia.org/practicing/akr/AIAB079690?dvid=&recspec=AIAB079690 [accessed October 10, 2010].

emphasis on motorized road users.[221] Until recently, wayfinding for pedestrians has largely focused on guides for blind and deaf pedestrians or those using assistive devices. In the past 10 years, more attention has been paid to the array of pedestrian road users.[222] Wayfinding for bicyclists is undergoing a major revision in the draft guidelines being developed by the American Association of State Highway and Transportation Officials (AASHTO), the standards-setting group for the transportation profession.[223]

Effectiveness and Impact

The availability of wayfinding has indirect impacts on people's decision to walk or bicycle. Pedestrians and bicyclists consider numerous factors when they select a route—not just the shortest or easiest path.[224,225] While providing information about pedestrian and bicycle options will make active transportation easier and more pleasant, more research is needed to determine the degree of impact it has on travel choices.[226]

Economic Factors

Wayfinding costs can vary widely.[227] For example, map postings may be expensive to set up and maintain compared to signs. There is little information on the economic benefits of enhancing wayfinding.

Conclusion

Increased and more effective usage of signage, maps, and wayfinding devices aimed at pedestrians and bicyclists can increase the ease and convenience of these modes of transportation.

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221 U.S. Department of Transportation Federal Highway Administration. 2009. *Manual on Uniform Traffic Control Devices (MUTCD). 2009 Edition*, Chapter 2D. Guide Signs—Conventional Roads. Available at: http://mutcd.fhwa.dot.gov/htm/2009/part2/part2d.htm#section2D50 [accessed October 10, 2010].

222 May, A., T. Ross, S. Bayer and M. Tarkiainen. 2003. Pedestrian Navigation Aids: Information Requirements and Design implications. *Pers Ubiquit Comput* 7: 331–338.

223 American Association of State Highway and Transportation Officials. 2010. *Draft AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities*.

224 Schlossberg, M., A.W. Agrawal, K. Irvin and V.L. Bekkouche. 2007. *How Far, by Which Route, and Why? A Spatial Analysis of Pedestrian Preference*. Mineta Transportation Institute. Washington, D.C: Federal Highway Administration. FHWA/CA/OR-2006/24.

225 Dill, J. and J. Gliebe. 2008. *Understanding and Measuring Bicycling Behavior: a Focus on Travel Time and Route Choice*. Oregon Transportation Research and Education Consortium. Report OTRC-RR-08-03. Available at: http://www.lulu.com/items/volume_64/5687000/5687029/1/print/OTREC-RR-08-03_Dill_BicyclingBehavior_FinalReport.pdf [accessed February 2011].

226 Winters, M. 2010. How Far Out of the Way Will We Travel? Built Environment Influences on Route Selection for Bicycle and Car Travel. *Transportation Research Record: Journal of the Transportation Research Board*.

227 Bicyclinginfo.Org. Do Bicyclists and Pedestrians Have the Same Wayfinding Needs? Available at: http://www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=48&lngFlag1=1&X=999&GRP_NBR=7&CM_maingroup=Support%20Facilities%20and%20Programs [accessed on June 21, 2011].

2.2.3 Conclusions: Increase Investments in Infrastructure that Supports Active Transportation

There has been a considerable increase in interest by the federal government in expanding transportation infrastructure investments that support active transportation—including sidewalks, multi-use trails, bicycle lanes and paths, bicycle boulevards, and street designs that narrow roadways and reduce traffic speed. Funding for such activities has risen substantially in the past 20 years.

As more research has established a link between infrastructure improvements and increases in active transportation, new comprehensive approaches are being developed. One concept that is being adopted currently is Complete Streets, which has resulted in increased levels of walking and bicycling and has enhanced safety for all road users.

SRTS has helped fund pedestrian and bicycle infrastructure improvements aimed at increasing active transportation choices for the trip to and from school. It has proven extremely popular. Incorporating pedestrian and bicyclist needs in overall design of infrastructure through measures such as improved lighting, better crosswalks, and slower speeds makes active transportation a more attractive choice. Additional pedestrian and bicyclist improvements that encourage active transportation are bicycle boulevards, which create low-speed networks of routes parallel to higher-speed auto routes, and added wayfinding and signage oriented to the non-motorized user.

2.3 Consider the Needs of All Road Users in Planning and Design Standards

2.3.1 Background: Consider the Needs of All Road Users in Planning and Design Standards

Definition

There are three aspects of transportation system operations that directly affect users' comfort and safety: the "level of service" (LOS) that the system provides them; the ease with which they can access and exit the transportation network when reaching their destinations (measured by means of "route analysis"); and the physical impact of vehicles on road users when crashes occur.

LOS is a systematic measure of the quality of the road user's experience. "Route analysis" examines the ease with which a user can access a destination within the transportation system. Vehicles' physical impact is a function of their design.

Current Status

Level of service has recently been expanded significantly beyond its traditional emphasis on motor vehicle volumes, speeds, and efficiency. Route analysis and vehicle design have not changed substantially in this direction, with route analysis still focused on motor vehicle access, and vehicle design concerned almost solely with the safety of vehicle occupants.

History

Design guidelines originally placed an emphasis on moving vehicles through the system with the greatest speed possible within the bounds of acceptable safety. The needs of non-motorized road users were secondary. Route analysis has not incorporated pedestrian and bicycle concerns to any large degree. While vehicle design, starting in 1967, has significantly increased the safety of occupants, there has been little concern for safety of road users outside the vehicle.

Potential for Increasing Active Transportation

Developing standards for incorporating the needs of pedestrians and bicyclists in transportation projects and making vehicles more forgiving to pedestrians and bicyclists when crashes do occur, are expected to improve safety for these road users.[228,229,230]

The following policies are considered:

Policy 1: Incorporate the use of multimodal level-of-service measures in transportation departments

Policy 2: Encourage use of pedestrian/bicycle route analysis as part of site and building concept development

P**olicy 3:** Encourage adoption of pedestrian-friendly vehicle design standards

[228] U.S. Department of Transportation Federal Highway Administration. 2010. *Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations*. Available at: http://www.fhwa.dot.gov/environment/bikeped/policy_accom.htm [accessed May 9, 2011].

[229] Bhatt, N., C. Peppard and S. Potts. 2010. *Getting Back on Track: Aligning State Transportation Policy with Climate Change Goals.* Natural Resources Defense Council and Smart Growth America.

[230] U.S. Department of Transportation Federal Highway Administration. *Pedestrian Safety in Communities, Resource Material.* Available at*:* http://safety.fhwa.dot.gov/ped_bike/ped_cmnity/ped_walkguide/resource7.cfm [accessed March 14, 2011].

2.3.2 Impact of Policies: Consider the Needs of All Road Users in Planning and Design Standards

Policy 1—Incorporate the use of multimodal level of service measures in transportation departments

Definition

Level of service (LOS) is a rating of the speed, convenience, comfort, and security of transportation facilities and services as experienced by users. Multimodal LOS measures how various modes—motor vehicles, walking, transit, and bicycling—interact or how changes in the LOS for one mode may affect the LOS for another.[231]

History

Traditionally, LOS focused on automobiles. Beginning in 2003, the National Cooperative Highway Research Program (NCHRP), the research group that is a partnership among state departments of transportation, in cooperation with the Federal Highway Administration began to investigate ways to include other perspectives—those of pedestrians, bicyclists, and transit users—in assessing LOS.[232] In 2008, it released its final report that included four models to help measure LOS for different modes, along with a user's guide.[233] The newest edition of the *Highway Capacity Manual*, the most authoritative reference, released in early 2011, contains expanded sections addressing a much broader population of road users, explicitly naming transit riders, pedestrians, and bicyclists.[234] Additionally, the United States Department of Transportation (U.S. DOT) has issued a policy statement that declares walking and bicycling "important" elements of projects that it funds.[235]

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231 Victoria Transport Policy Institute. 2010. *Multi-Modal Level-of-Service Indicators, Tools for Evaluating the Quality of Transport Services and Facilities.* TDM Encyclopedia. Available at: http://www.vtpi.org/tdm/tdm129.htm [accessed March 16, 2011].

232 Transportation Research Board. 2007. *Multimodal Level of Service Analysis for Urban Streets*. National Academies of Science. Washington, D.C. Available at: http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=824 [accessed May 19, 2011].

233 Transportation Research Board. 2008. *Multimodal Level of Service Analysis for Urban Streets*. NCHRP Report 616. National Academies of Science. Washington, D.C. Available at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_616.pdf [accessed May 19, 2011].

234 Transportation Research Board. *Highway Capacity Manual 2010.* National Academies of Science. Washington, D.C. http://trb.org/Main/Blurbs/Highway_Capacity_Manual_2010_HCM2010_164718.aspx [accessed May 19, 2011].

235 U.S. Department of Transportation Federal Highway Administration. 2010. *Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations*. Available at: http://www.fhwa.dot.gov/environment/bikeped/policy_accom.htm [accessed May 9, 2011].

Effectiveness and Impact

Currently there is little actual use by agencies of multimodal LOS for the planning and design of urban streets for transit, bicycle, and pedestrian modes.[236]

Economic Factors

Costs to state or local entities include obtaining software and paying for training to use the new models developed by the NCHRP, or to make modifications to existing transportation models to include multimodal LOS.

Conclusion

There is not yet sufficient data to measure the effectiveness of establishing requirements for states to employ multimodal LOS in the design of transportation projects. However, the number of states adopting such methods is growing, and more results should be available in coming years.[237]

Policy 2—Encourage use of pedestrian/bicycle route analysis as part of site and building concept development

Definition

A pedestrian/bicycle route analysis examines the routes that pedestrians and bicyclists will take into or out of a site.

History

Pedestrian and bicycle route analysis has not historically been a significant part of site or building concept development.[238]

Effectiveness and Impact

Encouraging pedestrian and bicycle route analysis as part of site development would expand on traditional route analysis.[239] It would assist in future planning for sidewalks, bike lanes, bike

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[236] Dowling and Associates. *State Laws and Policies Relating to Multimodal LOS Analysis*. Available at: http://www.dowlinginc.com/pdf/Legislation_CompleteStreets.pdf [accessed May 19, 2011].

[237] Ibid.

[238] U.S. Department of Transportation Federal Highway Administration. 2004. *Traffic Analysis Tools*. Office of Operations. Available at: http://ops.fhwa.dot.gov/aboutus/one_pagers/analysis_tools.htm [accessed October 10, 2010].

[239] Ibid.

racks, and medians and could aid in the location of entrances and exits and make walking and bicycling more attractive.[240]

Economic Factors

There are currently no studies that examine the economic costs or benefits of encouraging use of pedestrian and bicycle route analysis as part of a site's concept development. Requiring pedestrian and bicycle route analysis would help planners, landscape architects, architects, and developers determine how to position buildings most effectively for these active transportation modes. This could result in an offset for parking requirements if the information gathered could be used to estimate the number of people who would use active transportation to access the location, thus decreasing trip generation by vehicles and lessening the amount of parking needed.

Conclusion

Incorporating pedestrian and bicycle route analysis into site concept development would increase the understanding of how a site affects active transportation choices. Having information generated through pedestrian/bicycle route analysis would guide future planning for sidewalks, bike lanes, bike racks, and medians, making walking and bicycling more attractive.

Policy 3—Encourage adoption of pedestrian-friendly vehicle design standards

Definition

Pedestrian-friendly vehicle design reshapes the vehicle to reduce the injury caused to pedestrians when crashes with vehicles occur.[241, 242,243,244,245]

History

There are no specific standards in the U.S. for pedestrian-friendly vehicle design standards.

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240 Nara, A. and P.M. Torrens. 2007. *Spatial and Temporal Analysis of Pedestrian Egress Behaviour and Efficiency*. Proceedings of the 15th Annual ACM International Symposium on Advances in Geographic Information Systems. Seattle, Washington. 2007.

241 Schuster, P.J. 2006. *Current Trends in Bumper Design for Pedestrian Impact.* SAE 2006 World Congress & Exhibition, Detroit, USA.

242 World Health Organization. 2004. *World Report on Road Traffic Injury Prevention.* Geneva: World Health Organization.

243 Paine, M.P. and C.G. Coxon. 2000. *Assessment of Pedestrian Protection Afforded by Vehicles in Australia.* Presented at Impact Biomechanics & Neck Injury Conference. Sydney, March 2000.

244 Euro NCAP. 2010. *Vision and Mission*. Available at: http://www.euroncap.com/Content-Web-Page/60c0772f-99e6-4afa-bdb9-c147f9505706/vision-and-mission.aspx [accessed December 1, 2010].

245 Schuster, P.J. 2006. *Current Trends in Bumper Design for Pedestrian Impact.* SAE 2006 World Congress & Exhibition, Detroit, USA.

Effectiveness and Impact

Most deaths of pedestrians struck by vehicles are the result of traumatic brain injury resulting from the hard impact of the head against the hood or windshield.[246] Impacts with bumpers cause injuries to the lower limbs.[247] Universal adoption of pedestrian-oriented designs would prevent significant numbers of deaths and injuries.[248]

Economic Factors

The cost of implementing pedestrian-friendly vehicle designs can be very low, especially compared to occupant protection designs.[249]

Conclusion

Re-designing vehicles to reduce their impacts on pedestrians when crashes occur would reduce the number of fatalities and injuries.

2.3.3 Conclusions: Consider the Needs of All Road Users in Planning and Design Standards

There has been considerable progress toward incorporating the needs of all road users in the use of multimodal LOS in measuring the transportation system's effect on pedestrians and bicyclists and using those measures to design projects that take into account their needs. There has been little consideration of pedestrian and bicyclist needs in route analysis for understanding how pedestrians and bicyclists experience the transportation system around their destinations and of how vehicle design can be changed to reduce vehicles' impacts on pedestrians when crashes occur. For all three areas, considerably more data is needed to determine the extent of the likely benefits from such policies.

246 Hamer, M. 2005. *Stopping the Slaughter of Innocent Pedestrians*. *New Scientist* (2514). Available at: http://www.drive.com.au/editorial/article.aspx?id=10477 [accessed June 21, 2011].

247 Jain, S.L. 2004. Dangerous Instrumentality: The Bystander as Subject in Automobility. *Cultural Anthropology* 91 (1).

248 Breen, J. 2002. Protecting Pedestrians: Editorial. *British Medical Journal*, 324: 1109-110.

249 Ibid.

2.4 Make Public Transit Easier to Use for Pedestrians and Bicyclists

2.4.1 Background: Make Public Transit Easier to Use for Pedestrians and Bicyclists

Definition

A recurring obstacle to public transit use is the so-called last/first mile problem, which refers to the ending or starting leg of a journey. Walking and bicycling can be a solution.

History

While successive federal transportation bills, starting with the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, have increased funding for bicycle and pedestrian facilities, there has been little effort to coordinate pedestrian and bicycle facilities with transit spending.[250]

Current Status

There has been a significant increase in transit systems' efforts to carry more bicycles on their vehicles.[251]

Potential to Increase Active Transportation

Improving pedestrian and bicycle features on public transit vehicles and facilities surrounding transit stations and stops has a measurable effect on increasing the amount that people walk or bicycle to transit. Enhancing other aspects of the transit experience through route maps, smart fare cards, and other transit aids will also make transit a more attractive alternative for pedestrians and bicyclists.[252,253]

Policies to Make Public Transit Easier to Use for Pedestrians and Bicyclists

Policy 1: Establish dedicated bicycle sections and bicycle carriers on transit vehicles

Policy 2: Increase pedestrian and bicyclist access to transit stops and stations

Policy 3: Provide route maps, arrival times, schedules, and integrated fare systems

Policy 4: Encourage transit-oriented development

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250 Schneider, R. 2005. *TCRP Synthesis 62: Integration of Bicycles and Transit.* Transportation Research Board: Washington, D.C. Available at: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_62.pdf [accessed on June 19, 2011].

251 American Public Transportation Association. 2009. *2009 Public Transportation Fact Book.* Available at: http://www.apta.com/gap/policyresearch/Documents/APTA_2009_Fact_Book.pdf [accessed May 19, 2011].

252 Ewing, R. and R. Cervero. 2010. Travel and the built environment. *Journal of the American Planning Association,* 76 (3): 265-294.

253 Pucher, J., J. Dill and S. Handy. 2010. Infrastructure, Programs, and Policies to Increase Bicycling: An International Review. *Preventive Medicine*, 50: S106-S125.

2.4.2 Impact of Policies: Make Public Transit Easier to Use for Pedestrians and Bicyclists

Policy 1—Establish dedicated bicycle sections and bicycle carriers on transit vehicles

Definition

A bus bicycle carrier can hold two to three bicycles and can be used without assistance from the bus operator. On fixed- and light-rail transit systems entire cars or sections of a car can be designed to accommodate bicycles without interfering with other riders.

History

By 2008 70 percent of buses had bicycle racks.[254] On rail-based modes, most systems permit bicycles in cars, but with restrictions during peak periods. Folding bicycles are permitted on many trains and buses at all times.[255]

Effectiveness and Impact

Given that 53 percent of public transit trips in the U.S. are made by bus,[256] bus-bicycle integration has a significant potential impact. For rail transit, creating dedicated bicycle cars or areas for bicycles would extend the reach of bicycle travel considerably, given rail transit's generally greater speed.[257] Both efforts provide more transportation options.[258,259]

Economic Factors

There is limited data on the cost-benefit of investing in bicycle accommodations for rail transit.[260] For buses, accommodating bicycles with exterior racks is extremely cost-beneficial given that

254 American Public Transportation Association. 2009. *2009 Public Transportation Fact Book.* Available at: http://www.apta.com/gap/policyresearch/Documents/APTA_2009_Fact_Book.pdf [accessed May 19, 2011].

255 Metropolitan Transportation Authority. *MTA Bike & Ride.* Available at: http://www.mta.info/bike/ [accessed May 19, 2011].

256 American Public Transportation Association. 2010. *2010 Public Transportation Fact Book.* Available at: http://www.apta.com/resources/statistics/Documents/FactBook/APTA_2010_Fact_Book.pdf [accessed October 21,2010].

257 Martens, K. 2004. The Bicycle as a Feeding Mode: Experiences from Three European Countries. *Transportation Research Part D*, 9: 281-294.

258 Pucher, J. and R. Buehler. 2009. Integrating Bicycling and Public Transport in North America. *Journal of Public Transportation*, 12 (3): 79-104.

259 Hegger, R. 2007. Public Transport and Cycling: Living Apart or Together? *Public Transport International*, 2: 38-41.

260 McClintock, H. and D. Morris. 2003. Integration of cycling & light rapid transit: Realising the potential. *World Transport Policy & Practice*, 9 (3): 9-14.

they are inexpensive, easy to operate, and do not take up capacity within the vehicles themselves.[261]

Conclusion

Establishing dedicated bicycle areas and carriers on public transit vehicles helps make bicycling a more attractive option for a greater number of trips.[262]

Policy 2—Increase bicyclist and pedestrian access to transit stops and stations

Definition

Improvements to make transit more accessible to bicyclists and pedestrians include secure bicycle parking and storage[263, 264] and pedestrian-scale amenities such as wide walkways, protected crossings, and dedicated paths. Pedestrian improvements would result in calmer traffic movements directly adjacent to the station, increasing the safety of both bicyclists and drivers.[265, 266]

History

While bicycle parking around transit has increased, little attention has been paid to secure or covered facilities that would allow transit users to store their bicycles while they were on their trip. For pedestrians, barriers exist because many U.S. transit stations, built with automobile users in mind, are surrounded by large parking lots, which can make access to the stations difficult for non-motorized users.[267]

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261 Hagelin, C.A. 2005. *A Return on Investment Analysis of Bikes-on-Bus Programs*. National Center for Transit Research. Florida Department of Transportation: Tallahassee, Florida. NCTR 576-05. Available at: http://www.nctr.usf.edu/pdf/576-05.pdf [accessed on June 21, 2011]

262 Pucher, J., J. Dill and S. Handy. 2010. Infrastructure, Programs, and Policies to Increase Bicycling: An International Review. *Preventive Medicine*, 50: S106-S125.

263 Martens, K. 2004. The Bicycle as a Feeding Mode: Experiences from Three European Countries. *Transportation Research Part D*, 9: 281-294.

264 Pucher, J., J. Dill and S. Handy. 2010. Infrastructure, Programs, and Policies to Increase Bicycling: An International Review. *Preventive Medicine*, 50: S106-S125.

265 Pucher, J. and R. Buehler. 2009. Integrating Bicycling and Public Transport in North America. *Journal of Public Transportation*, 12 (3): 79-104.

266 Nabors, D., R. Schneider, D. Leven, K. Lieberman and C. Mitchell. 2008. *Pedestrian Safety Guide for Transit Agencies*. U.S. Department of Transportation Federal Highway Administration. FHWA-SA-07-017.

267 The Mineta Transportation Institute College of Business San José State University. 2002. *Envisioning Neighborhoods with Transit-Oriented Development Potential*. Available at: http://transweb.sjsu.edu/publications/envisioning/Envisioning.htm [accessed May 19, 2011].

Effectiveness and Impact

If access to transit is easy, safe, and convenient, more people will use it.[268] Supporting bicyclists at transit stations encourages transit ridership.[269,270,271] Limited study has been devoted to the ridership effects of making transit stops and stations safer and more "walkable."

Economic Factors

The space needed to store one automobile can accommodate 10 to 12 bicycles, making bicycle parking a more efficient use of land per unit of transportation than automobile parking.[272] Similarly, pedestrian infrastructure improvements are much less costly and have much broader benefits in terms of space and infrastructure than those for motor vehicles.[273]

Conclusion

Infrastructure improvements can increase bicyclist and pedestrian accessibility to transit and, in the case of bicyclists, increase the use of transit and the use of bicycles.[274]

Policy 3—Provide route maps, arrival times, schedules, and integrated fare systems

Definition

With the growth of smart phones and wider use of vehicle tracking devices, it is possible to deliver real-time information to transit patrons before they are on the system and while they are using it. [275,276] Smart card technology allows riders to pay fares for multiple agencies—bus, subway, light rail—with only one fare card, which makes using transit easier.[277,278,279]

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268 Schneider, R. 2005. *TCRP Synthesis 62: Integration of Bicycles and Transit.* Transportation Research Board: Washington, D.C. Available at: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_62.pdf [accessed on June 19, 2011].

269 Wardman, M., M. Tight and M. Page. 2007. Factors influencing the propensity to cycle to work. *Transportation Research Part A*, 41: 339-350.

270 Netherlands Ministry of Transport. 2009. *Cycling in the Netherlands*. The Hague, Netherlands. Available at: http://www.fietsberaad.nl/library/repository/bestanden/CyclingintheNetherlands2009.pdf [accessed October 22, 2010].

271 Martens, K. 2004. The bicycle as a feeding mode: Experiences from three European countries. *Transportation Research Part D*, 9: 281-294.

272 Schneider, R. 2005. *TCRP Synthesis 62: Integration of Bicycles and Transit.* Transportation Research Board: Washington, D.C. Available at: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_62.pdf [accessed on June 19, 2011].

273 Pucher, J. and L. Dijkstra. 2000. Making walking and cycling safer: Lessons from Europe. *Transportation Quarterly*, 54: 25-50.

274 Schneider, R. 2005. *TCRP Synthesis 62: Integration of Bicycles and Transit.* Transportation Research Board: Washington, D.C. Available at: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_62.pdf [accessed on June 19, 2011].

275 Eboli, L. and G. Mazzulla. 2009. A New Customer Satisfaction Index for Evaluating Transit Service Quality. *Journal of Public Transportation*, 12 (3): 21-37.

276 Tyrinopoulos, Y. and C. Antoniou. 2008. Public Transit User Satisfaction: Variability and Policy Implications. *Transport Policy*, 15 (4): 260-272.

277 Caulfield, B. and M. O'Mahony. 2009. A Stated Preference Analysis of Real-Time Public Transit Stop Information. *Journal of Public Transportation*, 12 (3): 1-20.

History

Nearly every major transit provider offers online route mapping and schedules. Smart cards, standard in all new systems, are rapidly being adopted by older systems.[280,281,282]

Effectiveness and Impact

Investing in transit service aids increases ridership.[283,284,285] Corresponding increases in physical activity should improve health.

Economic Factors

Because there is such a wide variety of devices and systems, it is not possible to derive a definitive cost estimate. However, it is generally acknowledged that many of these innovations, such as real-time tracking of vehicles and integrated smart fare cards, create co-benefits in terms of the transit system's operations.[286]

Conclusion

Transit aids, including route maps, schedules and fare, arrival and departure information, along with smart fare cards, can lead to increased public transit ridership. Transit systems in many cities have successfully implemented such services.

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278 Iseki, H., A. Demisch, B.D. Taylor and A.C. Yoh. 2008. *Evaluating the Costs and Benefits of Transit Smart Cards*. California PATH research report, UCB-ITS-PRR-2008-14.

279 Taylor, B.D., H. Iseki, M.A. Miller and M. Smart. 2009. *Thinking Outside the Bus: Understanding User Perceptions of Waiting and Transferring in Order to Increase Transit Use.* California PATH research report, UCB-ITS-PRR-2009-8.

280 Smart Card Alliance. *About Smart Cards: Applications: Transportation.* Available at: http://www.smartcardalliance.org/pages/smart-cards-applications-transportation [accessed February 28, 2011].

281 Iseki, H., A. Demisch, B.D. Taylor and A.C. Yoh. 2008. *Evaluating the Costs and Benefits of Transit Smart Cards*. California PATH research report, UCB-ITS-PRR-2008-14.

282 American Public Transportation Association. 2009. *2009 Public Transportation Fact Book*. April 2009. Available at: http://www.apta.com/gap/policyresearch/Documents/APTA_2009_Fact_Book.pdf [accessed: November 1, 2010].

283 Caulfield, B. and M. O'Mahony. 2009. A Stated Preference Analysis of Real-Time Public Transit Stop Information. *Journal of Public Transportation*, 12 (3): 1-20.

284 Chau, P.Y.K. and S. Poon. 2003. Octopus: an E-Cash Payment System Success Story. *Communications of the Association for Computing Machinery*, 46 (9): 129-133.

285 National Center for Transit Research at the Center for Urban Transportation Research, University of South Florida. 2005. *Enhancing the Rider Experience: The Impact of Real-Time Information on Transit Ridership*. Florida Department of Transportation. Available at: http://www.nctr.usf.edu/projects/Year5/576-15.html [accessed on June 21, 2011].

286 Transportation Research Board. 2010. Transit 2010, Volume 1. Transportation Research Record: *Journal of the Transportation Research Board*. (2143).

Policy 4—Encourage transit-oriented development

Definition

Transit-oriented development (TOD, also known as transit-oriented design) is high-density mixed-use development within walking distance of transit stations.[287,288,289]

History

Numerous municipalities and local governments have begun adopting land use policies that support TOD, but deployment has not been uniform or predictable.[290]

Effectiveness and Impact

TOD greatly reduces the need for driving.[291] Successful TODs reinforce both the community and the transit system and involve numerous components including: optimal transit system design; community partnerships; understanding local real estate markets; planning for TOD; coordination among local, regional, and state organizations; and providing the right mix of planning and financial incentives and resources.[292,293]

When coupled with measures to create a multi-modal transportation system, measures to facilitate TOD have often resulted in significantly high rates of transit use. More research, however, is needed to determine the degree to which residents of transit-oriented developments are "self-selecting," that is, already biased toward transit use before moving to the development.[294,295]

Economic Factors

Local governments' cooperation is essential in promoting TOD through plans, policies, zoning provisions, and incentives for supportive densities and designs. Development must be more than

287 Cervero, R., C. Ferrell and S. Murphy. 2002. *Transit-Oriented Development and Joint Development in the United States: a literature review*. TCRP Report Number 52. Transportation Research Board. National Academies of Science. Washington, DC.

288 California Department of Transportation. 2002. *Statewide Transit-Oriented Development Study: Factors for Success in California*.

289 TransitOrientedDevelopment.org. *Components of Transit Oriented Design*. Available at: http://www.transitorienteddevelopment.org/tod.html [accessed March 3, 2011].

290 Ibid.

291 California Department of Transportation. 2002. *Statewide Transit-Oriented Development Study: Factors for Success in California*.

292 Ibid.

293 TransitOrientedDevelopment.org. *Components of Transit Oriented Design*. Available at: http://www.transitorienteddevelopment.org/tod.html [accessed March 3, 2011].

294 Ewing, R. and R. Cervero. Travel and the Built Environment. *Journal of the American Planning Association* 6 (3): 265-294.

295 Cao, X., P. Mokhtarian and S. Handy. 2008. *Examining the Impacts of Residential Self-Selection on Travel Behavior: Methodologies and Empirical Findings*. Institute of Transportation Studies, UC Davis.

just adjacent to transit; it must be shaped by transit regarding parking, density, and/or building orientation to be considered transit-oriented.[296]

Altering land use regulations to support TOD requires that resources be devoted to updating comprehensive and economic development plans, as well as zoning, building, and subdivision codes. This primarily takes the form of planners' salaries and the costs related to public participation. TOD has the potential, if executed in tandem with multiple transit options, of adding substantially to government revenues in the form of sales and property taxes generated by the increased commercial and retail activity and land values.[297] The cost of supplying municipal services to TOD areas might appear to be higher, but could ultimately be lower if such development is constructed instead of lower-density development in undeveloped areas. While support for TOD is growing, many developers still consider these projects to be high risk.[298]

Conclusion

TOD can attract significant numbers of motorists to transit in areas that are experiencing rapid growth and rising traffic congestion and have an extensive transit network in place.[299]

2.4.3 Conclusions: Make Public Transit Easier to Use for Pedestrians and Bicyclists

Public transit is a natural partner to walking and bicycling, and by making transit easier for pedestrians and bicyclists to use, walking and bicycling's attractiveness as transportation alternatives increases. Transit authorities can make their vehicles and stops and stations more accessible to pedestrians and bicyclists by adding racks and bicycle parking and by improving walkways, entrances, and platforms. Transit aids, such as maps, route-finding applications, smart fare cards, and real-time arrival information can also enhance the attractiveness of transit and increase pedestrians' and bicyclists' transit use. The link between transit and pedestrians and bicyclists can also be strengthened by encouraging TOD—mixed-use, compact development near transit stops and stations—increasing the convenience of access to the transit system for those who walk and bicycle.

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296 California Department of Transportation. 2002. *Statewide Transit-Oriented Development Study: Factors for Success in California*.

297 Cervero, R., S. Murphy, C. Ferrell, N. Goguts, Y.H. Tsai, et al. 2004. *Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects*. TCRP Report 102. Transportation Research Board. National Academies of Science. Washington, D.C.

298 Livable Places. *Encouraging Transit Villages*. Available at: http://www.livableplaces.org/policy/todincentives.html [accessed March 3, 2011].

299 Cervero, R. 2004. *Transit Oriented Development in America: Contemporary Practices, Impacts, and Policy Directions.* International Planning Symposium on Incentives, Regulations, and Plans –The Role of States and Nation-States in Smart Growth Planning. National Center for Smart Growth Research and Education, University of Maryland Habiforum Foundation, The Netherlands September 30-October 1, 2004.

2.5 Conclusions for Chapter 2

Enhancing community design to promote active transportation creates a number of co-benefits in addition to the individual and environmental health benefits associated with the primary goal of increasing trips made by walking and bicycling. Every motor vehicle trip that is replaced by a walk or a bicycle ride means less pollution, congestion, noise, and other elements that affect quality of life and adds social capital in the form of stronger community ties and a more human-scale environment.

The elements of community design that encourage active transportation also lead to more livable communities and improved quality of life. Greater connectivity, achieved by keeping block sizes small enough to be comfortable and walkable, locating key destinations closer together, and giving incentives for more compact and mixed-use development all contribute to the vibrancy of a community.

With the increase in interest in expanding transportation infrastructure investments that support active transportation, new, more human-scale approaches to street design are being adopted. Policies like Complete Streets make roadways compatible for all users. Programs like Safe Routes to School organize the provision of pedestrian and bicycle infrastructure around children's trips to and from school, but they have the effect of enhancing infrastructure for all pedestrians and bicyclists and increasing active transportation choices for all.

Bicycle boulevards, improved lighting, better crosswalks, added wayfinding and signage oriented to the non-motorized user, and slower speeds make active transportation a more attractive choice and increase active transportation trips, while making a community more attractive and livable as well.

In roadway facilities' design and operation, the needs of all road users are being incorporated into performance measures like level of service. More consideration is needed for pedestrian and bicyclist route analysis and pedestrian-friendly vehicle design.

Finally, public transit is a natural partner to walking and bicycling, and by making it easier for pedestrians and bicyclists to use transit, walking and bicycling's attractiveness as transportation alternatives increases. While there has been some progress in transit systems' capacity for carrying bicycles, the integration of walking and bicycling with transit in terms of station and stop design can be expanded considerably, along with enhanced use of transit aids such as online arrival information and route planning. The link between transit and pedestrians and bicyclists can also be strengthened by encouraging more mixed-use, compact development near transit stops and stations, increasing the convenience of access to the transit system for those who walk and bicycle.

Chapter 3. Policies that Reduce Motor Vehicle-Related Injuries and Fatalities

3 Introduction: Policies that Reduce Motor Vehicle-Related Injuries and Fatalities

Through much of 1960s, 70s, and 80s, 40,000 to 50,000 people were killed each year in traffic crashes.[300] However, in the following decades, as effects were felt from major improvements in highway design, vehicle design, seat belt and anti-drunk driving laws, enforcement, and education, the number of fatalities began to drop. Even as vehicle miles traveled rose rapidly—tripling in the space of four decades[301]—the number of fatalities and injuries per mile driven

[300] Historical Statistics of the United States. *Motor Vehicle Traffic Fatalities and Fatality Rates: 1900–1995*. Historical Statistics of the United States, Millennial Edition. Available at: http://hsus.cambridge.org/HSUSWeb/toc/showTable.do?id=Df184-577 [accessed June 16, 2011].

[301] Historical Statistics of the United States. *Distance Traveled by Motor Vehicle Type and Highway Category: 1921-995*. Historical Statistics of the United States, Millennial Edition. Available at: http://hsus.cambridge.org/HSUSWeb/toc/showTable.do?id=Df184-577 [accessed June 16, 2011].

dropped by nearly 80 percent, a truly dramatic achievement.[302] In 2009, there were 33,808 traffic fatalities, the lowest number since 1950.

This progress was due to concerted policy efforts. For example, the use of seat belts in passenger vehicles alone saved an estimated 75,000 lives or more between 2004 and 2008.[303] Despite these successes, motor vehicle crashes continue to be the leading cause of fatality and injury for Americans age 1 to 34. In addition to the 33,808 deaths in 2009, there were more than 2 million injuries.[304] In 2000, crash-related costs (property damage, lost productivity, and medical expenses) totaled more than $230 billion.[305]

The dramatic reduction in the rate of traffic fatalities and injuries over the past decades and the more recent reduction in the absolute number of fatalities and injuries have been the result of targeted application of policies focused on three broad strategies:

- Preventing a traffic crash from happening in the first place (e.g., preventing alcohol-impaired driving, controlling speed, improving safe driving behavior, and improved vehicle handling)
- Reducing the level of injury in the event of a crash (e.g., increased use of seat belts, improvement in child restraint systems, and improvement in vehicle design in absorbing energy of a crash)
- Increasing the speed and quality of medical care after a crash has occurred (e.g., improving emergency medical services, reducing response times, improving care on site, and improved emergency hospital care).

Opportunities for Further Traffic Fatality and Injury Reductions

Very substantial additional progress can be achieved by a combination of improving and continuing to apply policies that have contributed to past success and developing and implementing new ones. We have identified 15 policies within seven areas where substantial reductions can be achieved in traffic fatalities and injuries. The seven areas are:

- Driving under the influence (DUI)
- Distracted driving

302 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Highlights of 2009 Motor Vehicle Crashes.* DOT HS 811 363.

303 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Lives Saved in 2008 by Restraint Use and Minimum Drinking Age Laws.* DOT HS 811 153.

304 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Highlights of 2009 Motor Vehicle Crashes.* DOT HS 811 363.

305 Centers for Disease Control and Prevention. Injury Prevention & Control. *Injury Fact Sheet.* Available at: http://www.cdc.gov/ncipc/anniversary/media/fs_trans.htm [accessed May 23, 2011].

- Younger drivers driving beyond their skills
- Older drivers driving beyond their abilities
- Excessive speed
- Failure to wear seat belts
- Inappropriate or no use of child restraint systems

Driving under the Influence (DUI)

Driving under the influence (DUI) is defined as driving with a blood alcohol concentration (BAC) equal to or greater than .08 grams per deciliter (g/dL), or 0.08 percent. The percentage of fatalities that occurred in DUI crashes decreased from 53 percent in 1982 to 34 percent in 1997. It then leveled off for two years, increased by 1 percent in 2000, and remained at that level for two years before it decreased to 33 percent in 2005.[306] In 2009, DUI-related crash fatalities still numbered almost 11,000. The drop in the DUI fatality rate is a public health success story that can be built upon by extending the use of ignition interlocks, increasing the use of sobriety checkpoints, maintaining and increasing enforcement of the national minimum drinking age at 21, and strengthening zero-tolerance laws for young drivers.

Distracted Driving

Distracted driving is playing an increasing role in traffic crashes. In 2005, driver distraction was a factor in 10 percent of all fatal crashes and 22 percent of all injury crashes. In 2009 distracted driving was a factor in 16 percent of all fatal crashes and 21 percent of injury crashes, resulting in 5,474 deaths and 448,000 injuries.[307] The rise in the use of cell phones and other electronic devices while driving has created a new form of distracted driving, and a large number of drivers admit to using cell phones or texting while driving. Countermeasures for reducing these distractions are in the early stages of implementation and evaluation. However, based on the success of similar policies in increasing seat belt use, providing incentives for states to pass cell phone laws and providing funds for enforcement and education should help reduce distracted driving collisions.

306 U.S. Department of Transportation National Highway Traffic Safety Administration. 2008. *Statistical Analysis of Alcohol-Related Driving Trends, 1982-2005.* DOT HS 180 942.

307 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Distracted Driving 2009.* DOT HS 811 379.

Younger Drivers Driving Beyond Their Skills

Motor vehicle crashes are the leading cause of death for adolescents in the U.S. In 2009, motor vehicle crashes killed 2,336 drivers age 15 to 20 and injured 196,000.[308] The crash rate per mile driven for 16- to 19-year-olds is four times that of older drivers. The risk is highest at age 16—twice as high as for 18- to 19-year-olds. [309] Strong graduated driver licensing (GDL) programs for new drivers are highly effective in reducing their crash risk.[310] GDL requires young drivers to drive under supervision and limits their exposure to hazardous situations until they gain necessary driving skills. While all states have GDL programs in place, increased benefits can be achieved by ensuring compliance and testing.

Older Drivers Driving Beyond Their Cognitive and Physical Abilities

The number of older (age 65 and over) licensed drivers increased 23 percent between 1999 and 2009; there were a total of 33 million licensed drivers age 65 and older in 2009. In 2008, they comprised 13 percent of all licensed drivers.[311,312] Drivers age 70 and older have (per capita and per mile traveled) elevated risk of being at fault for fatal crashes.[313,314] In addition, older adults have an increased susceptibility to injury and medical complications when involved in a crash.[315] For older drivers, the use of license evaluation for identifying perceptual or cognitive deficits reduces crashes.[316]

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308 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Young Drivers.* DOT HS 811 400.

309 Insurance Institute for Highway Safety. *Fatality Facts 2009: Teenagers.* Available at: http://www.iihs.org/research/fatality_facts_2009/teenagers.html [accessed March 30, 2011].

310 Williams, A.F. and Shults, R.A. 2010. Graduated Driver Licensing Research, 2007-Present: A Review and Commentary. *Journal of Safety Research*, 41: 77-84.

311 Stutts, J., Martell, C. and Staplin, L. 2009. *Identifying Behaviors and Situations Associated With Increased Crash Risk for Older Drivers.* Available at: http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811093.pdf [accessed May 23, 2011].

312 Insurance Institute for Highway Safety. 2010. *Fatality Facts 2009. Older people.* Available at: http://www.iihs.org/research/fatality_facts_2009/olderpeople.html [accessed April 7, 2011].

313 Stutts, J., Martell, C. and Staplin, L. 2009. *Identifying Behaviors and Situations Associated With Increased Crash Risk for Older Drivers.* Available at: http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811093.pdf [accessed May 23, 2011].

314 Insurance Institute for Highway Safety. 2010. *Fatality Facts 2009. Older people.* Available at: http://www.iihs.org/research/fatality_facts_2009/olderpeople.html [accessed April 7, 2011].

315 Centers for Disease Control and Prevention. Injury Prevention & Control: Motor Vehicle Safety. *Older Adult Drivers: Fact Sheet.* Available at: http://www.cdc.gov/MotorVehicleSafety/Older_Adult_Drivers/adult-drivers_factsheet.html [accessed May 23, 2011].

316 Nasvadi, G.C. and Wister, A. 2009. Do Restricted Driver's Licenses Lower Crash Risk Among Older Drivers? A Survival Analysis of Insurance Data From British Columbia. *The Gerontologist*, 49.4: 474-84. Available at: http://gerontologist.oxfordjournals.org/content/49/4/474.abstract [accessed June 10, 2010].

Speeding

In the most recent National Survey of Speeding and Unsafe Driving Attitudes and Behavior by the National Highway Traffic Safety Administration (NHTSA), more than 25 percent of drivers reported speeding on the day of the interview.[317] Speeding contributes to nearly one-third of fatal crashes. Under extreme weather-related road conditions, such as snow, slush, and ice, speeding is a factor in more than one-half of fatal crashes—54 percent on snowy or slushy roads and 59 percent on icy roads.[318] Encouraging use of automated speed enforcement cameras where appropriate and when used as an adjunct to traditional enforcement methods and engineering approaches is an important strategy for reducing excess speed.[319,320] Use of traffic calming methods can also reduce speed and increase safety and is particularly effective in reducing risk for vulnerable road users.[321]

Seat Belt Use

Studies on seat belt use have shown that they reduce the risk of fatal injury to front-seat passengers by 45 percent and reduce the risk of moderate to critical injury by 50 percent.[322] In 2010, nationwide seat belt use rose to 85 percent as measured by the NHTSA National Occupant Protection Use Survey (NOPUS).[323] However, a large number of deaths and injury occur each year because occupants are not wearing seat belts. A 2009 U.S. Department of Transportation study estimated that 1,652 additional lives could be saved and 22,372 serious injuries prevented annually in the U.S. if seat belt use rates rose to 90 percent in all states.[324] Although estimates of the impact vary, NHTSA estimates that each 1 percent increase in seat belt use could save 270 lives annually.[325]

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317 Royal, D. 2003. *National Survey of Speeding and Unsafe Driving Attitudes and Behavior: 2002, Volume II*, NHTSA, Washington, D.C. DOT HS 809 688.

318 U.S. Department of Transportation National Highway Traffic Safety Administration. 2007.Traffic Safety Facts. *Speeding.* DOT HS 810 998.

319 Pilkington, P. and Kinra, S. 2005. Effectiveness of Speed Cameras in Preventing Road Traffic Collisions and Related Casualties: Systematic Review. *British Medical Journal*, 330: 331-34.

320 Rodier, C.J.; Shaheen, S.A. and Cavanagh, E. 2007. *Automated Speed Enforcement in the U.S.: A Review of the Literature on Benefits and Barriers to Implementation.* Transportation Research Board Annual Meeting. Available at: http://pubs.its.ucdavis.edu/download_pdf.php?id=1097 [accessed July 27, 2010].

321 Victoria Transport Policy Institute. *Traffic Calming.* Available at: http://www.vtpi.org/tdm/tdm4.htm [accessed May 23, 2011].

322 U.S. Department of Transportation National Highway Traffic Safety Administration. 2000. *Fatality Reduction by Safety Belts for Front Seat Occupants of Cars and Light Trucks: Updated and Expanded Estimates Based on 1986-99 FARS Data*. DOT HS 809 199.

323 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Seat Belt Use in 2010—Overall Results.* DOT HS 911 378.

324 U.S. Department of Transportation National Highway Traffic Safety Administration. Traffic Safety Facts: 2009. *The Increase in Lives Saved, Injuries Prevented, and Cost Savings if Seat Belt Use Rose to at Least 90 Percent in All States.* DOT HS 811 140.

325 U.S. Department of Transportation National Highway Traffic Safety Administration. 2006. *FY2006 Budget Request Statement.* Dr. Jeff W. Runge, NHTSA Administrator. Available at: www.nhtsa.dot.gov/nhtsa/whatis/BB/2006/pages/AdminStmt.htm. [accessed May 11, 2011].

Seat belt use is perhaps the single most striking transportation safety success in recent decades. Expanding primary seat belt laws to all 50 states and increased funding for well-crafted enforcement will have significant paybacks in terms of increased safety.

Use of Age- and Size-Appropriate Child Safety Seats and Booster Seats

In the United States, 1,314 children age 14 and younger died in traffic crashes in 2009. For those children whose restraint use was known, 23 percent were unrestrained. NHTSA estimates that 309 children age 5 and under were saved by restraint use in 2009. An additional 63 lives could have been saved if child restraints had been used by all children age 5 and under. When used correctly, child safety seats reduce fatality rates in passenger vehicles by 71 percent for infants less than a year old and by 54 percent for toddlers age one to 4.[326] Surveys have found very high rates of inappropriate use of child safety seats and booster seats.[327] In 1999, NHTSA estimated that 68 deaths and 874 nonfatal injuries could be prevented each year if misuse of child restraints were eliminated.[328] NHTSA has developed age-based standards for their use, and incentives to states to adopt them, along with incentives for standards in child restraint designs would, along with increased funding for education and enforcement, help reduce deaths and injuries among child passengers.

Chapter 3 at a Glance

In this chapter we examine seven policies that could reduce motor vehicle-related injuries and fatalities. They are:

3.1 Decrease Driving Under the Influence (DUI)

3.2 Decrease Distracted Driving

3.3 Reduce the Incidence of Younger Drivers Driving Beyond Their Skills

3.4 Reduce the Incidence of Older Drivers Driving Beyond Their Cognitive and Physical Abilities

3.5 Reduce Speeding

3.6 Increase Seat Belt Use

3.7 Increase Use of Age- and Size-Appropriate Child Safety Seats and Booster Seats

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326 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Children*. DOT HS 811 387.

327 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Child Restraint Use in 2008 – Use of Correct Restraint Types.* DOT HS 811 132.

328 U.S. Department of Transportation National Highway Traffic Safety Administration.1999. *Final Economic Assessment, FMVSS No.213 and 225, Child Restraint Systems, Child Restraint Anchorage Systems*, Office of Regulatory Analysis. Available at: http://www.nhtsa.gov/cars/rules/rulings/ucra-omb-j08/econ/regeval.213.225.html [accessed May 21, 2011].

3.1 Decrease Driving Under the Influence (DUI)

3.1.1 Background: Decrease DUI

Prevalence of DUI

There has been a steady decline in the number of drivers found to be over the legal limit of 0.08 BAC in periodic national roadside surveys. In 1973, the figure was 7.8 percent; in 2007, it was 2.2 percent. (The surveys provide a relative measure, rather than an absolute measure, because they are carried out at specific times. Typically, DUI rates fluctuate depending on the time of day and day of the week.)[329]

Impact on Crash Risk

The risk of a fatal vehicle crash increases along with the driver's BAC among all groups.[330] Cognitive impairment sufficient to erode driving skills to dangerous levels begins at 0.02 BAC,[331] continuing to rise steeply as BAC exceeds 0.08, and becoming extremely high at a BAC greater than 0.15.[332]

Impact on Fatality

DUI crash fatalities decreased from 53 percent of all fatalities in 1982 to 34 percent in 1997.[333] However, since the mid-1990s, the percentage of fatalities attributed to DUI has leveled off, and in 2009 DUI contributed to 32 percent of all traffic fatalities, for a total of 10,839.[334]

Potential for Lives Saved

If all drivers on the road had BACs below 0.08 in 2009, 7,440 deaths would have been prevented.[335]

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329 Compton, R. and Berning, A. 2009. *Results of the 2007 National Roadside Survey of Alcohol and Drug Use by Drivers*. U.S. Department of Transportation National Highway Traffic Safety Administration. Washington, DC. DOT HS-811-175.

330 Zador, P.L., Krawchuk, S.A., Voas, R.B. 2000. *Relative Risk of Fatal and Crash Involvement by BAC, Age and Gender*. U.S. Department of Transportation National Highway Traffic Safety Administration. DOT HS 809 050.

331 Zador, P.L.; Krawchuk, S.A.; and Voas, R.B. 2000. Alcohol-Related Relative Risk of Driver Fatalities and Driver Involvement in Fatal Crashes in Relation to Driver Age and Gender: An Update Using 1996 Data. J*ournal of Studies on Alcohol*. May 2000: 387-395.

332 Peck, R.C.; Gebers, M.A.; Voas, R.B.; and Romano, E. 2008. The Relationship Between Blood Alcohol Concentration (BAC), Age, and Crash Risk. *Journal of Safety Research*, 39: 311-19.

333 U.S. Department of Transportation National Highway Traffic Safety Administration. 2008. *Statistical Analysis of Alcohol-Related Driving Trends, 1982-2005*. DOT HS 180 942.

334 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Alcohol-Impaired Driving*. DOT HS 811 385.

335 Insurance Institute for Highway Safety. 2011. Q&A's Alcohol #7 *What Proportion of Motor Vehicle Crashes Involves Alcohol?* Available at: http://www.iihs.org/research/qanda/alcohol_general.html [accessed May 23, 2011].

Policies for Reducing DUI

Over the past several decades, a number of policies and programs have been effective in reducing DUI fatalities and injuries but the number of DUI crashes remains unacceptably high. It is crucial to maintain or extend policies that have been successful and develop and deploy new policies to further reduce DUI-related injury and fatality. Below are four policies recommended to maintain and expand on the substantial gains made so far.[336]

Policy 1: Extend use of interlocks

Policy 2: Increase use of sobriety checkpoints

Policy 3: Maintain minimum drinking age law of age 21

Policy 4: Strengthen implementation and enforcement of zero-tolerance laws for young drivers

3.1.2 Impact of Policies: Decrease DUI

Policy 1—Extend use of ignition interlocks

Definition

Ignition interlocks prevent drivers from starting a motor vehicle if their blood alcohol concentration is above a specified level. Interlocks generally consist of four components: an alcohol detector, a system to retest the driver periodically (e.g., every 20-30 minutes) to ensure sobriety, tamper-proofing, and a log that records BAC levels.[337]

History of Deployment

The first use of ignition interlocks took place in 1986 in California. In 1992, NHTSA published "Model Specifications for Breath Alcohol Ignition Interlock Devices."[338]

As of 2011, 49 states had enacted laws that permit the use of interlocks for at least some DUI offenders. In some states, interlocks are optional; others limit their use to offenders with excessively high BAC levels; some mandate them for first-time offenses; others only for repeat offenders. Eleven states mandate interlocks for all DUI offenders. The number of interlocks in use in the U.S. more than doubled between 2006 and 2010, from approximately 100,000 to

[336] Centers for Disease Control and Prevention. 2011. *Policy Impact: Alcohol Impaired Driving.* National Center for Injury Prevention and Control, Division of Unintended Injury Prevention. Available at: http://www.cdc.gov/motorvehiclesafety/pdf/PolicyImpact-Alcohol-a.pdf [accessed May 19, 2011].

[337] Marques, Paul R., and Voas, Robert B. 2010. *Key Features for Ignition Interlock Programs*. DOT HS 811 262.

[338] Ibid.

212,000. Nevertheless, in many states with interlock laws, only 10 to 20 percent of offenders who are eligible for interlocks have them installed. [339]

Effectiveness and Impact

A 2005 study concluded that if all the drivers with previous DUI convictions within three years prior to the crash were restricted to a BAC of below 0.08, 777 lives could be saved.[340] A review conducted by the Centers for Disease Control and Prevention in the Guide for Community Preventive Services concluded that ignition interlocks are effective in reducing re-arrest rates for DUI, but the impact is limited because the device is used in a relatively small number of cases, and re-arrest rates revert once the device is removed.[341] Offering them as an option to less appealing alternatives, such as home confinement, could dramatically increase their use.[342]

Economic Factors

In most states, offenders bear the cost of purchasing and installing the interlock devices. Governments incur operational costs in supervising and enforcing the program. In some states, these costs are offset by fees collected from DUI offenders.[343] One estimate places the benefits at between three and seven times the costs of a program, with the larger benefits derived when interlocks are used on repeat offenders.[344]

Conclusion

Ignition interlocks are highly effective in preventing re-arrests for DUI, and evidence suggests that they reduce DUI crashes.[345] Increasing the number of interlocks and increasing the duration of their installation could significantly increase the number of DUI fatalities and injuries prevented.[346]

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339 National Conference of State Legislatures. *State Ignition Interlock Laws.* Available at: http://www.ncsl.org/default.aspx?tabid=13558 [accessed May 23, 2011].

340 Lund, A.K.; McCartt, A.T.; and Farmer, C.M. 2007. *Contribution of Alcohol-Impaired Driving to Motor Vehicle Crash Deaths in 2005.* Proceedings of the 18th International Conference on Alcohol, Drugs, and Traffic Safety (CD-ROM). Oslo, Norway: International Council on Alcohol, Drugs, and Traffic Safety.

341 Elder, R.W., Voas, R., Beirness, D., et al. 2011. Effectiveness of Ignition Interlocks for Preventing Alcohol-Impaired Driving and Alcohol-Related Crashes. *American Journal of Preventive Medicine,* 40 (3): 362-376.

342 Roth, R., Marques, R.P. and Voas, R.B. 2009. A Note on the Effectiveness of the House-arrest Alternative for Motivating DWI Offenders to Install Ignition Interlocks. *Journal of Safety Research,* 40 (6): 437-41.

343 Ibid.

344 Sprattler, Karen. 2009. *Ignition Interlocks-What You Need to Know: A Toolkit for Policymakers, Highway Safety Professionals, and Advocates.* DOT HS 811 246.

345 Elder, R.W., Voas, R., Beirness, D., et al. 2011. Effectiveness of Ignition Interlocks for Preventing Alcohol-Impaired Driving and Alcohol-Related Crashes. *American Journal of Preventive Mdeicine,* 40 (3): 362-376.

346 Task Force on Community Preventive Services. Recommendations on the Effectiveness of Ignition Interlocks for Preventing Alcohol-Related Driving and Alcohol-Related Crashes. *American Journal of Preventive Medicine,* 40 (3): 377.

Policy 2—Increase use of sobriety checkpoints

Definition

Sobriety checkpoints are law enforcement-conducted roadblocks where cars are stopped on a systematic basis to identify alcohol-impaired drivers. Once the driver is stopped, law enforcement personnel determine whether there is reason to suspect impairment. Only after that determination has been made can law enforcement personnel require the driver to submit to a sobriety test. This method is known as "selective testing." (When all drivers who are stopped are tested, it is known as "random testing.")[347]

Sobriety checkpoints are typically conducted in places and times when the number of alcohol-impaired drivers tends to be highest: in the late evening and on weekends. Sobriety checkpoints utilize the principle of general deterrence.[348] The checkpoints themselves net only a small number of DUI drivers; rather, the major purpose is to deter drunk driving before it occurs by increasing the perceived risk of arrest.[349] Publicity surrounding sobriety checkpoint programs serves to enhance the deterrent effect. Additionally, drivers' observations of checkpoints, or their experience of passing through them, can also have a deterrent effect.[350]

History of Deployment

As of June 2011, sobriety checkpoints were legal in 38 states and the District of Columbia. In 12 states, they are either explicitly prohibited by state law, or they are illegal under the state constitution, or the state does not have the authority to conduct them. Few states use them frequently; as many as 12 report carrying them out on a weekly basis, weather permitting.[351]

Effectiveness and Impact

Sobriety checkpoints are effective in reducing DUI and DUI-related crashes: one review of numerous programs found a median reduction of 20 percent in DUI fatal and injury crashes.[352] A

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[347] Elder, R.W., Shults, R.A., Sleet, D.A., Nichols J.L., Zaza S. and Thompson R.S. 2002. Effectiveness of Sobriety Checkpoints for Reducing Alcohol-Involved Crashes. *Traffic Injury Prevention*, 3 (4): 266-74.

[348] Fell, J.C., Lacey, J.H. and Voas, R.B. 2004. Sobriety Checkpoints: Evidence of Effectiveness is Strong, but Use is Limited. *Traffic Injury Prevention*, 5 (3): 220-227.

[349] Elder, R.W., Shults, R.A., Sleet D.A., Nichols J.L., Zaza S. and Thompson R.S. 2002. Effectiveness of Sobriety Checkpoints for Reducing Alcohol-Involved Crashes. *Traffic Injury Prevention*, 3 (4): 266-74.

[350] Fell, J.C., Lacey, J.H. and Voas, R.B. 2004. Sobriety Checkpoints: Evidence of Effectiveness is Strong, but Use is Limited. *Traffic Injury Prevention*, 5 (3): 220-227.

[351] Governors Highway Safety Association. 2010. *Sobriety Checkpoint Laws.* Available at: http://www.ghsa.org/html/stateinfo/laws/checkpoint_laws.html [accessed May 23, 2011].

[352] U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *Countermeasures That Work: A Highway Safety Countermeasure Guide For State Highway Offices.* Fifth Edition.

co-benefit of sobriety checkpoints is a reduction in other dangerous behavior, such as driving without a valid license.[353]

Economic Factors

NHTSA's high-visibility enforcement incentive grants can be used to fund sobriety checkpoints.[354] Implementation costs vary widely, depending on the size of the checkpoint, the type and number of personnel used, and the salary scales of the agency.[355] Many local agencies over-estimate the budget and staffing needed to conduct checkpoint operations.[356] One common misconception is that an effective checkpoint requires 15 to 20 personnel.[357] However, a highly effective and efficient sobriety checkpoint can be carried out with as few as three to five officers.[358] Studies show that sobriety checkpoints have a positive benefit:[359,360] one estimated a six-to-one return.[361]

Conclusion

Sobriety checkpoints are highly effective, and substantial benefits could be derived by expanding their use by: (i) encouraging states that do not have legal authority to do checkpoints to work toward gaining it; (ii) expanding the number of checkpoints through increased funding; and (iii) expanding awareness of how they work.

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353 Elder, R.W., Shults, R.A., Sleet, D.A., Nichols J.L., Zaza S. and Thompson R.S. 2002. Effectiveness of Sobriety Checkpoints for Reducing Alcohol-Involved Crashes. *Traffic Injury Prevention*, 3 (4): 266-74.

354 U.S. Department of Transportation National Highway Traffic Safety Administration. *Fact Sheets: Section 410 SAFETEA-LU Fact Sheet*. Available at: http://www.nhtsa.gov/Laws+&+Regulations/Section+410+SAFETEA-LU+Fact+Sheet [accessed May 21, 2011].

355 Miller, T.R. and Levy, D.T. 2000. Cost-Outcome Analysis in Injury Prevention and Control: Eighty-Four Recent Estimates for the United States. *Medical Care*, 38 (6): 562-582.

356 Fell, J.C., Lacey, J.H. and Voas, R.B. 2004. Sobriety Checkpoints: Evidence of Effectiveness is Strong, but Use is Limited. *Traffic Injury Prevention*, 5 (3): 220-227.

357 Lacey, J.H., Ferguson, S.A., Kelley-Baker, T. and Rider, R.P. 2006. Low-manpower checkpoints: Can they provide effective DUI enforcement in small communities? *Traffic Injury Prevention*, 7 (3): 213-218.

358 Fell, J.C., Lacey, J.H. and Voas, R.B. 2004. Sobriety Checkpoints: Evidence of Effectiveness is Strong, but Use is Limited. *Traffic Injury Prevention*, 5 (3): 220-227.

359 Stuster, J.W. and Blowers, P.A. 1995. *Experimental Evaluation of Sobriety Checkpoint Programs.* DOT HS-808-287. U.S. Department of Transportation National Highway Traffic Safety Administration. Washington, D.C.

360 Shults, R.A., et al. and Task Force on Community Preventive Services. 2001. Reviews of Evidence Regarding Interventions to Reduce Alcohol-Impaired Driving. *American Journal of Preventive Medicine*, 21 (4 [S1]): 66-88.

361 Miller, T.R., Galbraith, M.S. and Lawrence, B.A. 1998. Costs and Benefits of a Community Sobriety Checkpoint Program. *Journal of Studies on Alcohol*, 59 (4): 462-68.

Policy 3—Maintain national minimum legal drinking age law of age 21

Definition

The National Minimum Legal Drinking Age (MLDA) Act of 1984 withheld a portion of federal highway funding if states did not adopt legislation to prohibit persons under age 21 from purchasing or publicly possessing alcohol.[362]

History of Deployment

States are free to set their own MLDAs, because the federal government does not have the authority. Before the passage of the 1984 act, state MLDAs varied. By 1988, the MLDA in all 50 states and the District of Columbia had been set at age 21, although states differ in how they regulate alcohol use, possession, and purchase by underage persons.[363]

Effectiveness and Impact

An MLDA of age 21 is effective in reducing fatal crashes in the short and long term:[364] with a median reduction of 17 percent.[365] NHTSA estimates that since 1975, an estimated 27,677 lives have been saved as a result of the change to an age 21 MDLA, and in 2009 alone, 623 lives were saved.[366] Lowering the MLDA to age 18 or 19 would likely increase the number of traffic fatalities dramatically, particularly in this age group. Even under current laws, as recently as 2009, 33 percent of drivers between ages 15 and 20 who were involved in fatal crashes had been drinking.[367] MLDA laws of age 21 provide benefits that extend beyond traffic safety: people under age 21 consume less alcohol overall and continue this behavior through their early 20s.[368] Although many underage youth continue to consume alcohol, they drink less and experience fewer alcohol-related injuries and deaths than before the minimum age was raised to 21.[369]

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362 Toomey, T.L., Nelson, T.F. and Lenk, K.M. 2009. The Age-21 Minimum Legal Drinking Age: A Case Study Linking Past and Current Debates. *Addiction*, 104 (12): 1958-1965.

363 Ibid.

364 U.S. Department of Transportation National Highway Traffic Safety Administration. 2011. Traffic Safety Facts. *Lives Saved in 2008 by Restraint Use and Minimum Drinking Age Laws.* DOT HS 811 153.

365 Shults RA et al. Review of the Evidence Regarding Interventions to Reduce Alcohol-Impaired Driving. *American Journal of Preventive Medicine,* 2001: 21 (45).

366 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Young Drivers.* DOT HS 811 400.

367 Ibid.

368 O'Malley, P.M. and Wagenaar, A.C. 1991. Effects of Minimum Drinking Age Laws on Alcohol Use, Related Behaviors and Traffic Crash Involvement Among American Youth: 1976-1987. *Journal of Studies on Alcohol and Drugs* 52: 478-491.

369 Wagenaar, A.C. 1993. Minimum Drinking Age and Alcohol Availability to Youth: Issues and Research Needs. In: Hilton, M.E. and Bloss, G., eds. Economics and the Prevention of Alcohol-Related Problems. National Institute on Alcohol Abuse and Alcoholism (NIAAA) Research Monograph No. 25, NIH Pub. No. 93-3513. Bethesda, MD: NIAAA. 1993: 175-200.

Economic Factors

The costs to enforce an MLDA of age 21 are incurred across a wide range of agencies (e.g., alcohol control and licensing entities, local, and state police). There appear to have been no attempts to develop a comprehensive estimate of the costs of implementing and enforcing this policy. Benefits can be inferred by the numbers of lives saved as noted earlier.

Conclusion

Age 21 MLDA laws are in effect in all 50 states and have had a demonstrable effect in reducing traffic fatalities among underage drivers and alcohol consumption among underage youth. The evidence is overwhelming that the age 21 MLDA should be maintained. Given that underage drivers are still involved in a large number of alcohol-impaired crashes, intensified enforcement of this policy would have significant benefits.

Policy 4—Strengthen implementation and enforcement of zero-tolerance laws for young drivers

Definition

Zero-tolerance laws set a maximum BAC of 0.02 for drivers under age 21, and impose immediate penalties such as license suspension and fines.[370]

History of Deployment

Under the 1995 National Highway Systems Designation Act, federal highway funding was withheld from states that did not adopt zero-tolerance laws. By 1998, all 50 states and the District of Columbia were in compliance.[371]

Effectiveness and Impact

Zero-tolerance laws result in a reduction of 9 to 24 percent in the fatal crash rate[372] despite difficulty in enforcement because low BAC impairment can be difficult to detect.[373] While youths indicate that zero-tolerance laws would be strong deterrents, knowledge that they exist is limited in the general population.[374]

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[370] Carpenter, C. 2004. . How Do Zero Tolerance Drunk Driving Laws Work? *Journal of Health Economics* 23 (1): 61-83.

[371] Shults, Ruth, et al. 2001. Reviews of Evidence Regarding Interventions to Reduce Alcohol-Impaired Driving. *American Journal of Preventive Medicine* 21 (4S): 66-88.

[372] Guide to Community Preventive Services. *Reducing Alcohol-Impaired Driving: Lower BAC for Young or Inexperienced Drivers.* Available at: http://www.thecommunityguide.org/mvoi/aid/lowerbaclaws.html [accessed May 23, 2011].

[373] Shults, Ruth, et al. 2001. Reviews of Evidence Regarding Interventions to Reduce Alcohol-Impaired Driving. *American Journal of Preventive Medicine*, 21(4S) (2001): 66-88.

[374] Voas, R.B., Tippetts, A.S. and Fell, J.C. 2003. Assessing the Effectiveness of Minimum Legal Drinking Age and Zero Tolerance Laws in the United States. *Accident Analysis and Prevention*, 35: 579-587.

Economic Factors

As with the MLDA, administration and enforcement costs associated with zero-tolerance laws are incurred across a wide range of agencies. One study put the cost at $29 (in 1997 dollars) per each underage driver. While it found that the laws resulted in net benefits, they were not quantified.[375]

Conclusion

Zero-tolerance laws have been in place in all states since 1998 and have proven to be effective in helping reduce alcohol-impaired crashes and fatalities among underage drivers. Increased benefits of zero-tolerance laws can be realized by increased funds for education and enforcement.

3.1.3 Conclusions: Decrease Driving Under the Influence (DUI)

DUI crash fatalities decreased from 53 percent in 1982 to 32 percent of all traffic fatalities in 2009.[376,377] Since 1995, the incidence of DUI has stabilized, yet the level remains unacceptably high,[378] and the 10,839 alcohol-related traffic fatalities that occurred in 2009 indicate there is still room for significant progress. Our review shows that significant additional savings in lives and dollars could be achieved through (i) expanding interlock programs, (ii) increasing the use of sobriety checkpoints, (iii) maintaining the MDLA 21 policy and expanding enforcement, and (iv) strengthening enforcement of zero-tolerance laws.

3.2 Decrease Distracted Driving

3.2.1 Background: Decrease Distracted Driving

Prevalence of Distracted Driving

In 2009, driver distraction was involved in 16 percent of all fatal crashes and 20 percent of all injury crashes. Cell phone use was involved in 18 percent of distracted driving crash deaths and 5 percent of the injuries, making it the single largest category of distracted driving behavior resulting in crashes. These numbers are believed to understate the problem, considering that cell

375 Miller, T.R. 2001. The Effectiveness Review Trials of Hercules and Some Economic Estimates for the Stables. *American Journal of Preventive Medicine*, 2 1 (4S): 11.

376 U.S. Department of Transportation National Highway Traffic Safety Administration. 2008. *Statistical Analysis of Alcohol-Related Driving Trends, 1982-2005*. DOT HS 180 942.

377 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Alcohol-Impaired Driving*. DOT HS 811 385.

378 Williams, A.F. 2006. Alcohol-Impaired Driving and Its Consequences in the United States: The Past 25 years. *Journal of Safety Research*, 37: 123-138.

phone ownership has grown dramatically in recent years, from 13 percent in 1995 to 87 percent today.[379]

Impact on Crash Risk

In a study that included minor and non-injury crashes, as well as near-crashes, 80 percent of all crashes involved the driver looking away (the standard measure for distraction) immediately before the crash, as did 65 percent of near-crashes.[380]

Impact on Fatality and Injury

In 2009, driver distraction was involved in 16 percent of all fatal crashes and 20 percent of all injury crashes, resulting in 5,474 deaths and 448,000 injuries.[381]

Potential for Lives/Injury Saved

No large-scale studies have been conducted, in part because of the relatively short time that laws against distracted driving (generally targeting cell phone use) have been in effect.

Policies for Decreasing Distracted Driving

Policy 1: Provide incentive grants to states to pass cell phone laws

Policy 2: Fund enforcement programs for cell phone and other distracted driving violations

Policy 3: Fund distracted driving education programs

3.2.2 Impact of Policies: Decrease Distracted Driving

Policy 1—Provide incentive grants to states to pass cell phone laws

Definition

Federal incentive grants offer additional incentive funds or make certain portions of a state's federal transportation dollars contingent on a state passing a specific traffic safety law—in this

379 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Distracted Driving 2009*. DOT HS 811 379.

380 U.S. Department of Transportation National Highway Traffic Safety Administration. 2006. *The 100-Car Naturalistic Driving Study. Phase II*. Available at: http://www.distraction.gov/research/PDF-Files/The-100-Car-Naturalistic-Driving-Study%20.pdf [accessed June 13, 2011].

381 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Distracted Driving 2009*. DOT HS 811 379.

case, banning cell phone use while driving.[382] Incentive programs have already been used to raise the minimum drinking age, lower the legal BAC to 0.08, and implement seat belt laws.

History of Deployment

Several bills were introduced during the 2009-2010 Congress to encourage states to regulate cell phone use while driving.[383] Already, 33 states, the District of Columbia, and Guam have passed some kind of ban on text messaging while driving; but only eight states, the District of Columbia, and the Virgin Islands prohibit drivers from using hand-held phones. The laws differ by type of driver (e.g., commercial, private vehicle), age (e.g., novice drivers), and other factors (e.g., primary or secondary enforcement). Federal incentives could accelerate this process and provide uniformity across jurisdictions.[384] The U.S. Department of Transportation (U.S. DOT) convened Distracted Driving Summits in 2009 and 2010 to bring together experts in the field to discuss this emerging problem.[385] In October of 2009, the president issued an executive order banning federal employees from texting while driving on the job,[386] and the U.S. DOT banned texting by commercial drivers the following year.[387]

Effectiveness Studies

There is evidence that laws against cell phone use tend to discourage drivers from talking on cell phones in the short run.[388] Given the success of incentive grants for encouraging DUI and seat belt laws, it is likely that incentive grants would be effective for accelerating the passage of uniform cell phone laws. Given the impact of driver distraction on crash risk, it is likely that cell phone laws will be effective in reducing fatalities, but systematic research is needed.

Projected Impact

A majority of respondents in one survey reported having engaged in talking on handheld phones, sending a text message, or email while driving.[389] Cell phone laws are relatively new and studies should be conducted on the effectiveness of bans on their use while driving, but early studies

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382 The Library of Congress. *S.1938—Distracted Driving Prevention Act of 2009* (Reference Change Senate – RCS) Available at: *http://thomas.loc.gov/cgi-bin/query/z?c111:S.1938.RCS*: [accessed May 18, 2011].

383 Ibid.

384 U.S. Department of Transportation. *State Laws on Distracted Driving*. Available at: http://www.distraction.gov/state-laws/ [accessed June 13, 2011].

385 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *Transportation Secretary Ray LaHood Kicks Off Second National Distracted Driving Summit.* NHTSA press release. September 21, 2010.

386 The White House Office of the Press Secretary. *Federal Leadership on Reducing Text Messaging while Driving*. October 1, 2009.

387 U.S. Department of Transportation. 2010. *Transportation Secretary Ray LaHood Announces Federal Ban on Texting for Commercial Truck Drivers*. Press release. January 26, 2010.

388 Braitman, K.A.and McCartt, A.T. 2010. National Reported Patterns of Driver Cellphone Use. *Traffic Injury Prevention*, 11 (6): 543-548.

389 Stutts J.C., et al. 2003. *The Role of Driver Distraction in Traffic Crashes*. Prepared for the AAA Traffic Safety Foundation. Available at: http://www.aaafoundation.org/pdf/distraction.pdf [accessed July 9, 2010].

suggest they reduce crashes under a number of common driving conditions. [390] Cell phone use (either handheld or hands-free) reduces the amount of brain activity available for tasks associated with undisturbed driving by 37 percent[391] and delays a driver's reactions as much as having a legally impaired BAC of 0.08.[392] Risk of a collision increases by a factor of four when a cell phone is being used,[393] and risk is also associated with a hands-free phone.[394]

Economic Factors

Costs of implementation and enforcing cell phone laws are likely to be similar to implementing and enforcing laws regarding seat belt use.

Conclusion

The past success of incentive grants in strengthening other driver safety laws and developing uniformity across jurisdictions suggests this approach would work for cell phone regulations as well.

Policy 2—Fund enforcement programs for cell phone and other distracted driving violations

Definition

Enforcement programs use public education and outreach combined with law enforcement activities such as checkpoints or enforcement drives to create "general deterrence," in which the proscribed behavior is reduced due to a general increased awareness of the law and increased perceived probability of being apprehended when breaking the law. This is the model used by the very successful federally funded Click It or Ticket (CIOT) seat belt enforcement program.[395]

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390 Kolko, J.D. 2009. The Effects of Mobile Phones and Hands-Free Laws on Traffic Fatalities. *The B.E. Journal of Economic Analysis & Policy*, 9 (1).

391 Just, M.A., Keller, T.A. and Cynkar, J. 2008. A Decrease in Brain Activation Associated With Driving When Listening to Someone Speak. *Brain Research,* 1205: 70-80.

392 Strayer, D.L., Drews, F.A., Crouch, D.J. and Johnston, W.Q. 2006. *Why Do Cell Phone Conversations Interfere with Driving?*

393 Redelmeier D.A., and Tibshirani R.J. 1997. Association between cellular-telephone calls and motor vehicle collisions. *New England Journal of Medicine,* 336: 453-8.

394 McCartt AT, Hellinga LA, Bratiman KA. 2006. Cell phones and driving: Review of research. *Traffic Injury Prevention,* 7 (2): 89-106.

395 U.S. Department of Transportation National Highway Traffic Safety Administration. 2002. *Evaluation of Click it or Ticket Model Programs.* Available at: http://www.nhtsa.gov/people/injury/airbags/clickit_ticket/clickitcomposite/clickit_composite.pdf [accessed May 23, 2011].

History of Deployment

To date, there have been no major dedicated federal funding programs for enforcing cell phone or other distracted driving laws. [396] NHTSA is currently conducting and evaluating demonstration programs in Hartford, CT and Syracuse, NY to test the applicability of the same enforcement model used in CIOT to handheld cell phone use while driving.[397]

Effectiveness Studies

Enforcement of bans on hand-held cell phones has led to greater compliance,[398,399,400] but there is little experience in enforcing bans on hands-free devices.[401,402]

Projected Impact

Using CIOT as a proxy for a nationwide distracted driving enforcement program, consistent, vigorous, and well-publicized enforcement is the single most effective strategy for changing behavior.[403] There is nothing to indicate the same would not hold true for distracted driving.[404]

Economic Factors

There would be benefits from reducing distracted driving crashes. Costs would be more difficult to estimate, given the wide range of individual agency practices.[405]

Conclusion

Federally funded enforcement has proven effective in the CIOT seat belt enforcement program. For cell phone use in particular, enforcement increases compliance. A national enforcement

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396 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts Research Note. *High Visibility Enforcement Demonstration Programs in Connecticut and New York Reduce Hand-Held Phone Use.* DOT HS 811 376.

397 U.S. Department of Transportation. *Transportation Secretary Ray LaHood Announces First Enforcement Crackdown Campaign on Distracted Driving: Pilot Programs in Hartford, CT and Syracuse, NY Are Latest Effort in DOT's Fight Against Distracted Driving*. Press Release. Available at: http://www.distraction.gov/files/for-media/4.08.10-Demo.pdf [accessed May 23, 2011].

398 McCartt, A.T., et al. 2007. Longer Term Effects of Washington, D.C. Law on Drivers' Hand-Held Cell Phone Use. *Traffic Inj Prev*, 8 (2): 199-204.

399 McCartt A.T., et al. 2004. Longer Term Effects of New York's Law on Drivers' Hand-Held Phone Use. *Inj Prev*, 10 (1): 11-5.

400 McCartt, A.T., et al. 2006. Effects of Washington, D.C. Law on Drivers' Hand-Held Cell Phone Use. *Traffic Inj Prev*, 7 (1): 1-5.

401 Jacobsen, D., et al. 2010. Reducing Distracted Driving – Regulation and Education to Reduce Traffic Injuries and Fatalities. *JAMA*, 303 (14): 1419-1420.

402 National Safety Council. 2010. *Understanding the Distracted Brain: Why Driving While Using Hands-Free Cell Phones is Risky Behavior*. White Paper.

403 Reinfurt, D.W. 2004. Documenting the Sustainability of a Mature Click it or Ticket Program: The North Carolina Experience. *Journal of Safety Research*, 35 (2): 181-188

404 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *Distracted Driving.* Available at: *http://www.nhtsa.gov/Distracted* [accessed May 28, 2010].

405 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *U.S. DOT Targets 45 Million Americans Not Buckling Up*. Press Release May 24, 2010. Available at: http://www.nhtsa.gov/PR/DOT-101-10 [accessed July 16, 2010].

campaign, using intense, short-duration, highly publicized enforcement periods could reduce the incidence of distracted driving.

Policy 3—Fund distracted driving education programs

Definition

A distracted driving education program would include campaigns to educate drivers about the dangers of distracted driving via media messages.

History of Deployment

There is no dedicated distracted driving education program. NHTSA is developing a media program that it intends to make available in 2011.[406]

Effectiveness Studies

Little is known about the effectiveness of educational campaigns about the dangers of distracted driving. Generally, education or public awareness campaigns alone do not change driver behavior.[407] They are effective when combined with enforcement campaigns.[408]

Projected Impact

There is little information with which to evaluate the impact of distracted driving education programs; any such programs should be accompanied by rigorous evaluation.

Economic Factors

There is insufficient information at this time to determine the resultant savings and benefits, though the scale of the costs could be suggested by the fact that a recent nationwide advertising campaign promoting seat belt use cost $8 million.[409]

Conclusion

Given the lack of available data on the value of public education campaigns, the exact potential value of a campaign against distracted driving cannot be accurately determined. Nonetheless, the

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406 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *Overview of the National Highway Traffic Safety Administrations Driver Distraction Program.* DOT HS 811 299.

407 Insurance Institute for Highway Safety. 2001. *Insurance Institute for Highway Safety Status Report, May 2001.* Available at: http://www.iihs.org/externaldata/srdata/docs/sr3605.pdf [accessed May 23, 2011].

408 Vasudevan, V., Nambisan, S.S., Singh, A.K., and Pearl, T. 2009. Effectiveness of Media and Enforcement Campaigns in Increasing Seat Belt Usage Rates in a State with a Secondary Seat Belt Law. *Traffic Inj Prev*, 10 (4): 330-9.

409 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *U.S. DOT Targets 45 Million Americans Not Buckling Up.* Press Release May 24, 2010. Available at: http://www.nhtsa.gov/PR/DOT-101-10 [accessed May 23, 2011].

success of similar campaigns in other areas when combined with enforcement suggests that this approach would be effective in reducing distracted driving as well.

3.2.3 Conclusions: Decrease Distracted Driving

Distracted driving is involved in 16 percent of all fatal crashes and 20 percent of all injury crashes. Three policies at the federal level have potential for reducing this risk: (1) incentive grants to states to pass rigorous and effective bans, (2) grants to support high-visibility enforcement, and (3) support for driving education programs in conjunction with enforcement.

3.3 Reduce Incidence of Younger Drivers Driving Beyond Their Skills

3.3.1 Background: Reduce Incidence Younger Drivers Driving Beyond Their Skills

Prevalence of Younger Drivers Driving Beyond Their Skills

Drivers between age 15 and 20 comprised 6.4 percent (13.3 million) of the total number of licensed drivers in the U.S. in 2008, a 5.1 percent increase over the 12.7 million young drivers in 1999.[410] While there is no direct measure of the share of younger drivers driving beyond their skills, their lack of experience and lack of driving skills has shown a strong association with increased crash risk.[411]

Impact on Crash Risk

The crash rate per mile driven for 16- to 19-year-olds is four times that of older drivers. It peaks for drivers age 16—who experience a crash rate twice as high as 18- to 19-year-olds.[412]

Impact on Fatality and Injury

Motor vehicle crashes are the leading cause of death for 15- to 20-year-olds in the U.S. In 2009, this age group accounted for 11 percent of motor vehicle crash deaths.[413] In 2009, motor vehicle crashes killed 2,336 drivers age 15 to 20 and injured 196,000.[414]

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410 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010 Traffic Safety Facts. 2009 Data *Young Drivers.* DOT HS 811 400.

411 Mayhew D.R. and Simpson H.M. 1990. *New to the Road Young Drivers and Novice Drivers: Similar Problems and Solutions*. Ottawa. Traffic Injury Research Foundation.

412 Insurance Institute for Highway Safety. *Fatality Facts 2009: Teenagers*. Available at: http://www.iihs.org/research/qanda/alcohol_gener Available at: http://www.iihs.org/research/fatality_facts_2009/teenagers.html [accessed March 30, 2011].

413 Ibid.

414 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Young Drivers.* DOT HS 811 400.

Potential for Lives/Injury Saved

Reducing younger drivers' level of risk per mile driven to the level of the overall driving population's risk per mile would prevent a large number of fatalities and injuries.

Policy for Reducing Incidence Younger Drivers Driving Beyond Their Skills

Policy 1: Strengthen graduated licensing for new drivers

3.3.2 Impact of Policy: Reduce Incidence of Younger Drivers Driving Beyond Their Skills

Policy 1—Strengthen graduated licensing for new drivers

Definition

Graduated Driver Licensing (GDL) programs require young drivers to drive under supervision and limit their driving privileges while they gain necessary driving skills.[415] There are three stages of a GDL system. The learner stage involves supervised driving, culminating in a licensing test for restricted driving privileges. The intermediate stage involves unsupervised driving limited to less hazardous situations and times of day. The full privilege stage culminates with successfully passing a licensing test for full licensure.[416] Seven key components of a successful GDL program have been identified. They include setting a sufficiently high minimum age for learner's permits and establishing minimum periods for the time required before passing to the next stage, including minimum numbers of supervised hours, and restrictions on night driving and passengers.

History of Deployment

Currently, 49 states and the District of Columbia employ three-stage GDL programs, which were instituted after federal guidelines were issued in the mid-1990s.[417]

Effectiveness Studies

States whose GDL programs had at least five of the seven elements had greater reductions in fatal crashes of 16-year-olds.[418] GDL programs result in double-digit reductions in the number of crashes among young drivers as a whole, with specific figures varying, depending on how many

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415 Traffic Injury Research Foundation. 2006. *Reducing the Crash Risk for Young Drivers.* Available at: http://www.aaafoundation.org/pdf/ReducingTeenCrashes.pdf [accessed May 23, 2011].

416 Governors Highway Safety Association. 2010 *Graduated Driver Licensing Laws*. Available at: http://www.ghsa.org/html/stateinfo/laws/license_laws.html [accessed March 11, 2010].

417 Ibid.

418 AAA Foundation. 2007. *Nationwide Review of Graduated Driver Licensing*.

of the seven elements are in place.[419,420,421,422,423] GDL shows promise in particular for reducing nighttime crashes and crashes of vehicles with multiple teen passengers.[424]

Projected Impact

Based on 2008 data on driver fatalities among 16-year-old drivers and a conservative estimate of an average 20 percent reduction in fatal crashes associated with GDL programs, 321 lives could be saved annually among 16-year-old drivers.[425] More stringent nighttime restrictions are associated with larger reductions, as are laws limiting teenage passengers to zero or one.[426]

Economic Factors

Young people ages 15 to 24 account for 30 percent of the total costs of motor vehicle injuries for men and 28 percent of the total costs of motor vehicle injuries for women, while they represent only 14 percent of the U.S. population.[427] This suggests that even small reductions in young driver risk would produce significant benefits in health care costs alone.

Conclusion

Younger drivers represent 6.4 percent of drivers; yet they account for 23 percent of traffic fatalities. GDL can significantly reduce crash risk and fatalities. The main barriers to effectiveness of GDL laws are compliance and enforcement.

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419 Centers for Disease Control and Prevention. Injury Prevention & Control: Motor Vehicle Safety. *Teen Drivers: Fact Sheet* Available at: http://www.cdc.gov/motorvehiclesafety/teen_drivers/teendrivers_factsheet.html [accessed May 23, 2011].

420 Nebraska Department of Motor Vehicles. 2010. *Graduated Licensing Law Statistics By Age In Fatal and Injury Crashes.*. Available at: http://www.dmv.ne.gov/highwaysafety/pdf/tn20-AllFInjGDL.pdf [accessed June 18, 2011].

421 Insurance Institute for Highway Safety. *Q&As: Teenagers – Graduated Driver Licensing.* Available at: http://www.iihs.org/research/qanda/gdl.html [accessed May 23, 2011].

422 Williams, A.F. and Shults, R.A. 2010. Graduated Driver Licensing Research, 2007-Present: A Review and Commentary. *Journal of Safety Research*, 41: 77-84.

423 Chen, L., Baker, S.P. and Li, G. 2006. Graduated Driver Licensing Programs and Fatal Crashes of 16-year-old Drivers: A National Evaluation. *Pediatrics*. American Academy of Pediatrics. 118 (1): 56-62.

424 Masten, S.V. and Hagge R.A. 2004. Evaluation of California's Driver Licensing Program. *Journal of Safety Research*, 35: 523-35.

425 Chen, L., Baker, S.P. and Li, G. 2006. Graduated Driver Licensing Programs and Fatal Crashes of 16-year-old Drivers: A National Evaluation. *Pediatrics*. American Academy of Pediatrics. 118 (1): 56-62.

426 McCartt, A.T., Teoh, E.R., Fields, M., Braitman, K.A. and Hellinga, L.A. 2010. Graduated Licensing Laws and Fatal Crashes of Teenage Drivers: A National Study. *Traffic Injury Prevention*, 11 (3): 240-248.

427 Centers for Disease Control and Prevention. Injury Prevention & Control: Motor Vehicle Safety. *Teen Drivers: Fact Sheet* Available at: http://www.cdc.gov/motorvehiclesafety/teen_drivers/teendrivers_factsheet.html [accessed May 23, 2011].

3.3.3 Conclusions: Decrease Incidence of Younger Drivers Driving Beyond Their Skills

Younger drivers experience disproportionately high proportions of fatalities and traffic crash risks. GDL laws reduce these risks. Ensuring compliance and strengthening testing and restrictions can reduce them even more.

3.4 Reduce the Incidence of Older Drivers Driving Beyond Their Cognitive and Physical Abilities

3.4.1 Background: Reduce the Incidence of Older Drivers Driving Beyond Their Cognitive and Physical Abilities

Prevalence of Older Drivers Driving Beyond Their Cognitive and Physical Abilities

In 2008, drivers age 65 and older comprised 13 percent of all licensed drivers.[428,429] While there has been a significant increase in the number of these older drivers—rising 23 percent from 1999 to 2009—there is little knowledge of how many of those drivers are at risk due to driving beyond their cognitive and physical abilities.[430]

Impact on Risk

Older drivers tend to limit their driving to times when conditions are safest and drive fewer miles than younger drivers. They have lower incidences of impaired driving.[431,432] However, people age 70 and older are retaining their driver's licenses longer and driving more miles than in the past.[433] Additionally, drivers age 70 and older have an elevated risk per capita and per mile traveled of being at fault for fatal crashes.[434,435]

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428 U.S. Department of Transportation Federal Highway Administration. 2008. *Highway Statistics 2008. Distribution of Licensed Drivers – 2008 by Sex and Percentage in Each Age Group and Relation to Population.* Table DL-20 Available at: http://www.fhwa.dot.gov/policyinformation/statistics/2008/dl20.cfm#foot1 [accessed May 23, 2011].

429 U.S. Department of Transportation National Highway Traffic Safety Administration. 2008. Traffic Safety Facts. *Older Population.* DOT HS 811 161. Available at: http://www-nrd.nhtsa.dot.gov/Pubs/811161.PDF [accessed May 23, 2011].

430 Centers for Disease Control and Prevention. *Injury Prevention and Control: Motor Vehicle Safety. Older Adult Drivers: Get the Facts*. Available at: http://www.cdc.gov/Motorvehiclesafety/Older_Adult_Drivers/adult-drivers_factsheet.html [accessed April 7, 2011].

431 Ibid.

432 U.S. Department of Transportation National Highway Traffic Safety Administration. 2008. Traffic Safety Facts. *Older Population.* DOT HS 811 161.

433 Insurance Institute for Highway Safety. 2010. *Fatality Facts 2009, Older People.* Available at: http://www.iihs.org/research/fatality_facts_2009/olderpeople.html [accessed April 7, 2011].

434 Stutts, J., Martell, C. and Staplin, L. 2009. *Identifying Behaviors and Situations Associated With Increased Crash Risk for Older Drivers.* National Highway Traffic Safety Administration. Available at: http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811093.pdf [accessed June 18, 2011].

Impact on Fatality/Injury

In 2008, adults age 65 and older made up 15 percent of all traffic fatalities.[436] Traffic fatalities by age tend to increase starting at age 70, and they increase notably after age 80. Adults age 65 and above have an increased susceptibility to injury and medical complications when involved in a crash.[437] In 2008, 183,000 adults age 65 and older were injured in traffic crashes.[438]

Potential for Lives/Injury Saved

If the older driver crash rate per mile driven could be reduced to the level of the crash rate for the overall driving population, a large number of fatalities and injuries could be prevented, especially among drivers age 70 and older when fragility tends to increase.[439]

Policy for Reducing the Incidence of Older Drivers Driving Beyond Their Cognitive Abilities and Physical Skills

Policy 1: Encourage license evaluation programs

3.4.2 Impact of Policy: Reduce Incidence of Older Drivers Driving Beyond Their Cognitive and Physical Abilities

Policy 1—Encourage license evaluation programs

Definition

License evaluation programs focus on identifying older drivers who have experienced declines in physical and cognitive functions. There is no uniform set of standards for assessment, but the process often includes a vision test, cognitive skill test, and driving test.[440] License restrictions based on assessments can include daylight-only motor vehicle operation.

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435 Insurance Institute for Highway Safety. 2010. *Fatality Facts 2009, Older People.* Available at: http://www.iihs.org/research/fatality_facts_2009/olderpeople.html [accessed April 7, 2011].

436 Ibid.

437 Centers for Disease Control and Prevention. Injury Prevention & Control: Motor Vehicle Safety. *Older Adult Drivers: Fact Sheet* Available at: http://www.cdc.gov/MotorVehicleSafety/Older_Adult_Drivers/adult-drivers_factsheet.html [accessed May 23, 2011].

438 U.S. Department of Transportation National Highway Traffic Safety Administration. Traffic Safety Facts. 2008 Data *Older Population.* DOT HS 811 161.

439 Insurance Institute for Highway Safety. 2010. *Fatality Facts 2009, Older People.* Available at: http://www.iihs.org/research/fatality_facts_2009/olderpeople.html [accessed April 7, 2011]..

440 Governors Highway Safety Association. 2011. *Mature Driver Laws.* Available at: http://www.ghsa.org/html/stateinfo/laws/olderdriver_laws.html [accessed May 19, 2011].

History of Deployment

As of 2010, 28 states and the District of Columbia have special provisions for older drivers; these include increased frequency of license renewal, vision and road tests, in-person license renewals, and doctors' notes proving competency.[441]

Effectiveness Studies

Requiring in-person license renewal was associated with a significantly lower fatality rates.[442] Placing some kind of restrictions on licenses lowered crash risk among drivers age 66 years and older and may reduce the number of fatal crashes. These restrictions were most often a prohibition against night-time driving and restrictions on the maximum speed.[443]

Projected Impact

License evaluation programs appear to reduce fatalities and crashes among older drivers, but more work is needed to evaluate programs and identify which elements contribute to the gains.

Economic Factors

Costs include developing valid tests, as well as screening methods, in addition to the cost of administering tests and enforcing restrictions.[444]

Conclusion

Restricting licensing and requiring in-person renewals led to reduced crash and fatality risks. Further research is needed to develop screening and testing methods that will identify drivers at risk with the required accuracy.

3.4.3 Conclusions: Reduce Incidence of Older Drivers Driving Beyond Their Cognitive and Physical Abilities

Older drivers experience disproportionately high fatality, injury, and crash risks. While limited research has been conducted about implementing driver assessment programs for older drivers, findings suggest that programs would result in reduced crash and fatality risks.

441 Ibid.

442 Ibid.

443 Nasvadi, G.C. and Wister, A. 2009. Do Restricted Driver's Licenses Lower Crash Risk Among Older Drivers? A Survival Analysis of Insurance Data From British Columbia. *The Gerontologist* 49.4: 474-84.

444 U.S. Department of Transportation National Highway Traffic Safety Administration. 2003. *Model Driver Screening and Evaluation Program: Final Technical Report.*. DOT HS 809 583.

3.5 Reduce Speeding

3.5.1 Background: Reduce Speeding

Prevalence

In a nationwide survey, about 75 percent of drivers reported driving over the speed limit in the month preceding the survey, and more than 25 percent reported speeding on the day it took place.[445]

Impact on Crash Risk

Speeding contributes to crash risk because it makes the driving task more difficult by reducing the driver's ability to maneuver safely, increases the stopping distance of the vehicle, and extends the distance the vehicle travels while the driver reacts. The impact of speeding on crash risk is greater under poor weather conditions such as snow, slush, and ice.[446]

Impact on Fatality and Injury

In 2008 speeding was a factor in 31 percent of fatal crashes, with 11,674 lives lost.[447] Speeding increases the severity of crashes in general and especially in crashes between vehicles and pedestrians or bicyclists.[448] Speeding-related fatalities are disproportionately more common among younger drivers, male drivers, and alcohol-impaired drivers.[449]

Potential for Lives/Injury Saved

Given that excessive speed is a contributing factor in 31 percent of fatal crashes, any efforts that reduce speeding will result in a significant number of lives saved and injuries prevented.

Policies for Reducing Speeding

Two policies are considered that have shown substantial potential for reducing speed and therefore speed-related fatalities and injuries.

Policy 1: Encourage use of automated speed enforcement (ASE) (where appropriate and as an adjunct to traditional enforcement methods and engineering approaches)

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445 Royal, D. 2003. *National Survey of Speeding and Unsafe Driving Attitudes and Behavior: 2002, Volume II*, (DOT HS 809 688), NHTSA, Washington, D.C.

446 U.S. Department of Transportation National Highway Traffic Safety Administration. 2008. Traffic Safety Facts. *Speeding*. DOT HS-811-166.

447 Ibid.

448 Rosen, E., Stigson, H., Sander, U. 2009. Pedestrian Fatality Risk as a Function of Car Impact Speed. *Acc Anal Prev.* 41: 536-542.

449 U.S. Department of Transportation National Highway Traffic Safety Administration. 2008. Traffic Safety Facts. *Speeding*. DOT HS-811-166.

Policy 2: Use traffic calming (and other engineering techniques) to reduce speeds

3.5.2 Impact of Policies: Reduce Speeding

Policy 1—Encourage use of automated speed enforcement (ASE)

Definition

Automated speed enforcement (ASE) detects a speeding vehicle (usually with a camera) as it passes a location and photographs the license plate, while creating a record of the date, time, location, and speed. A ticket is mailed to the car's registered owner.[450]

History of Deployment

States began to adopt ASE in the early 1970s, but by the early 1990s, many had abandoned the practice due to public complaints related to privacy, fairness, and reliability.[451] As of 2010, 12 states plus the District of Columbia permit ASE statewide, while another seven permit it under certain circumstances.[452] ASE is used in at least 16 other countries.[453]

Effectiveness Studies

ASE is associated with substantial reductions in speeding and crashes,[454,455,456,457] in some instances by several orders of magnitude (e.g. from 300 crashes per year on one highway to

[450] Retting, R.A. and Farmer, C.M. 2003. Evaluation of Speed Camera Enforcement in the District of Columbia. *Transportation Research Record: Journal of the Transportation Research Board* 830: 34-37.

[451] Rodier, C.J., Shaheen, S.A. and Cavanagh, E. 2007. *Automated Speed Enforcement for California: A Review of Legal and Institutional Issues.* Institute of Transportation Studies. California PATH Research Report: UCB-ITS-PRR-2007-14.

[452] Insurance Institute for Highway Safety. Highway Loss Data Institute. *Q&A: Speed – Law Enforcement.* Available at: http://www.iihs.org/research/qanda/speed_lawenf.aspx [accessed July 22, 2010].

[453] Thomas, L.J., Srinivasan, R., Decina, L.E. and Staplin, L. 2008. Safety Effects of Automated Speed Enforcement Programs: Critical Review of International Literature. *Transportation Research Record: Journal of the Transportation Research Board*, 2078: 117-126.

[454] Pilkington, P. and Kinra, S. 2005. Effectiveness of Speed Cameras in Preventing Road Traffic Collisions and Related Casualties: Systematic Review. *British Medical Journal*, 330: 331-34.

[455] Rodier, C.J.; Shaheen, S.A. and Cavanagh, E. 2007. *Automated Speed Enforcement in the U.S.: A Review of the Literature on Benefits and Barriers to Implementation*. Transportation Research Board Annual Meeting, July 2007.

[456] Washington, S., Shin, K. and van Schalkwyk, I. 2007. *Evaluation of the City of Scottsdale Loop 101 Photo Enforcement Demonstration Program.* Final Report AZ-684. Arizona Department of Transportation.

[457] Harsha, B. and Hedlund, J. 2007. *Changing America's Culture of Speed on the Roads.* AAA Foundation. Available at: http://www.aaafoundation.org/pdf/HarshaHedlund.pdf [accessed June 20, 2010].

30).[458,459] In other cases, there were drops of 20 to 25 percent for overall crashes and as much as 71 percent for fatal crashes.[460,461]

Projected Impact

ASE can have a very strong impact on speeding, as long as it is designed as a safety-enhancing program and implemented in the context of a general deterrence approach.

Economic Factors

Some ASE programs generate net revenue, but most are revenue neutral or require subsidies.[462] Comprehensive cost-benefit studies indicate positive cost-benefits.[463]

Conclusion

ASE is potentially a highly effective tool in reducing vehicle speeds and subsequent crashes and injuries. Barriers remain, however, due to bureaucratic and legal complications, privacy concerns, constitutional challenges, and perceptions that ASE is merely a method for generating revenue rather than reducing the incidence of speeding.

Policy 2—Use traffic calming to reduce speeds

Definition

Traffic calming uses infrastructure such as street closures, medians, forced turn islands, speed bumps, roundabouts, curb extensions, and raised intersections and crosswalks to slow motorized traffic to make conditions safer and more comfortable for pedestrians, bicyclists, and other non-motorized road users, without increasing volumes and traffic speeds on other parts of the road network.[464]

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458 Ibid.

459 Transportation Research Board. 1998. *Special Report 254; Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits*. Washington, D.C. National Academy of Sciences.

460 Mountain, L.J., Hirst, W.M. and Maher, M.J. 2004. Costing Lives or Saving Lives? A Detailed Evaluation of the Impact of Speed Cameras on Safety. *Traffic Engineering and Control* 45: 280-87.

461 Pilkington, P. and Kinra, S. 2005. Effectiveness of Speed Cameras in Preventing Road Traffic Collisions and Related Casualties: Systematic Review. *British Medical Journal*, 330: 331-34.

462 Blackburn, R. and Gilbert, D. 1995. *Enforcement of Traffic Laws: Synthesis of Highway Practice 219.* Washington, D.C. National Academy Press.

463 Greg Chen, G., Warburton, R. 2006. Do Speed Cameras Produce Net Benefits? Evidence from British Columbia, Canada. *Journal of Policy Analysis and Management*, 25 (3): 661–678.

464 Kirschbaum, J.B., Axelson, P.W., Longmuir, P.E., Mispagel, K.M., Stein, J.A. and Yamada, D.A. 2001. *Designing Sidewalks and Trails for Access: Part II of II, Best Practices Design Guide.* Chapter 9. U.S. Department of Transportation Federal Highway Administration. Available at: http://www.fhwa.dot.gov/environment/sidewalk2/index.htm[accessed May 23, 2011].

History of Deployment

The first traffic calming program was developed in Delft, Holland in the 1960s. In the U.S., the first places to use it were Berkeley, California, and Seattle, Washington, in the early 1970s. Since traffic calming is most feasible for local streets, it has largely been the concern of city governments. A more recent variant on traffic calming is "Complete Streets," which is an evolving concept expressed in federal and some state transportation policies, guiding street designs and improvements to take into account the needs of all users.[465]

Effectiveness Studies

The number and variety of traffic calming measures makes it difficult to provide an overall estimate of effectiveness.[466] The installation of roundabouts is associated with crash reductions.[467,468] Curb extensions reduce vehicle speed;[469] speed bumps tend to reduce the fastest speeds on local streets[470] and are also associated with lowering child pedestrians' traffic injury risk;[471] and raised crosswalks can reduce pedestrian fatalities and injuries.[472]

Projected Impact

While there is no comprehensive evaluation of the entire suite of traffic calming devices,[473] in general, traffic calming reduces speeds and creates a more pedestrian- and bicycle-friendly street environment.[474]

Economic Factors

Cost-benefit calculations of traffic calming measures are highly situational and location-based.[475,476]

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465 Smith, R., Reed, S. and Baker, S. 2010. Street Design: Part 1—Complete Streets. *Public Roads*, 74 (1).

466 Retting, R.A., Ferguson, S.A., McCartt, A.T. 2003. A Review of Evidence-Based Traffic Engineering Measures Designed to Reduce Pedestrian-Motor Vehicle Crashes. *American Journal of Public Health*, 93 :1456–63.

467 Flannery, A. and Datta, T.K. 1996. Modern Roundabouts and Traffic Crash Experience in United States. *Transportation Research Record: Journal of the Transportation Research Board*, 1553: 103-109.

468 Retting, R.A., Ferguson, S.A., McCartt, A.T. 2003. A Review of Evidence-Based Traffic Engineering Measures Designed to Reduce Pedestrian-Motor Vehicle Crashes. *American Journal of Public Health*, 93 :1456–63.

469 McCourt, R.S. 1998. *Survey of Neighborhood Traffic Management Performance and Results*. Institute of Transportation Engineers. Available at: http://www.ite.org/traffic/documents/CCA98A01.pdf [accessed June 13, 2010].

470 Ewing, R. 2001. *Impacts of Traffic Calming*. TRB Circular E-C019: Urban Street Symposium.

471 Tester, J.M., Rutherford, G.W., Wald, Z. and Rutherford, M.W. 2004. A Matched Case-Control Study Evaluating the Effectiveness of Speed Humps in Reducing Child Pedestrian Injuries. *American Journal of Public Health*, 94 (4): 646-650.

472 Bahar, G., Masliah, M., Wolff, R. and Park, P. 2007. *Desktop Reference for Crash Reduction Factors*. Federal Highway Administration. FHWA-SA-07-015. Available at: http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa09028/resources/CRF%20Desktop%20Reference.pdf [accessed July 28, 2010].

473 Retting, R.A., Ferguson, S.A., McCartt, A.T. 2003. A Review of Evidence-Based Traffic Engineering Measures Designed to Reduce Pedestrian-Motor Vehicle Crashes. *American Journal of Public Health*, 93:1456–63.

474 Mao, J. and Koorey, G. 2010. *Investigating and Modelling the Effects of Traffic Calming Devices*. IPENZ Transportation Group Conference 2010. Christchurch, New Zealand. Available at: http://ir.canterbury.ac.nz/handle/10092/3897 [accessed July 28, 2010].

Conclusion

Traffic calming can be effective in reducing vehicular speeds and traffic volumes, although the potential for "migration" of volume to other locations should be considered. Additional research is needed to understand the cost-benefits of traffic calming over a wider area and to identify suitable locations.

3.5.3 Conclusions: Reduce Speeding

Speeding is very common and is a major contributor to crashes and injuries. Automated speed enforcement is very effective in reducing speeding and crashes, but it faces barriers related to public perception. Traffic calming measures can be effective on the local level.

3.6 Increase Seat Belt Use

3.6.1 Background: Increase Seat Belt Use

Prevalence of Seat Belt Use

In 2010, U.S. seat belt use rose to 85 percent as measured by the National Highway Traffic Safety Administration's (NHTSA's) National Occupant Protection Use Survey (NOPUS).[477] Seat belt use varies among different demographic groups and is lower among males, 16- to 24-year-olds, pickup truck occupants, African-Americans, and solo drivers.[478,479]

Impact on Fatality

Seat belts reduce the risk of fatal injury to front-seat passengers by 45 percent and the risk of moderate to critical injury by 50 percent.[480]

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475 Litman, T.A. 1999. *Traffic Calming Benefits, Costs and Equity Impacts.* Victoria Transport Policy Institute. Available at: http://www.vtpi.org/calming.pdf [accessed June 14, 2010].

476 Elvik, R., Vaa, T., Hoye, A. (eds). 2009. *The Handbook of Road Safety Measures*. Emerald Group Publishing Limited.

477 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Seat Belt Use in 2010—Overall Results.* DOT HS 911 378.

478 U.S. Department of Transportation National Highway Traffic Safety Administration: *Occupant Restraint Use in 2009-Results from the National Occupant Protection Use Survey Controlled Intersection Study*. Available at: http://www-nrd.nhtsa.dot.gov/Pubs/811414.pdf [accessed January 2011].

479 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Seat Belt Use in 2008—Demographic Results.* DOT HS 811 183.

480 U.S. Department of Transportation National Highway Traffic Safety Administration. 2000. *Fatality Reduction by Safety Belts for Front Seat Occupants of Cars and Light Trucks: Updated and Expanded Estimates Based on 1986-99 FARS Data*. DOT HS 809 199.

Potential for Lives Saved

A 2009 U.S. Department of Transportation study estimated that 1,652 additional lives could be saved and 22,372 serious injuries prevented annually in the U.S. if seat belt use rates rose to 90 percent.[481] Slightly more than half of the savings would come from the 20 states that do not have primary seat belt laws.[482] NHTSA estimates that each 1 percent increase in seat belt use could save 270 lives annually.[483]

Policies for Increasing Seat Belt Use

Policies over the past several decades have led to increased seat belt use. However, a substantial percent of fatalities and injuries still occur to unrestrained occupants.

Policy 1: Expand primary seat belt laws to all 50 states

Policy 2: Increase funding for enhanced enforcement

3.6.2 Impact of Policies: Increase Seat Belt Use

Policy 1—Expand primary seat belt laws to all 50 states

Definition

Primary seat belt laws allow a police officer to stop a vehicle and issue a ticket to the driver solely because of a seat belt violation.

History of Deployment

New York passed the first primary seat belt law in 1984. Currently, 31 states and the District of Columbia have primary seat belt laws.[484]

Effectiveness and Impact

States with primary seat belt laws have higher use rates[485] and lower fatality rates.

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481 U.S. Department of Transportation National Highway Traffic Safety Administration. Traffic Safety Facts: 2009. *The Increase in Lives Saved, Injuries Prevented, and Cost Savings if Seat Belt Use Rose to at Least 90 Percent in All States*. DOT HS 811 140.

482 Ibid.

483 U.S. Department of Transportation National Highway Traffic Safety Administration. 2006. *FY2006 Budget Request Statement.* Dr. Jeff W. Runge, NHTSA Administrator. Available at: www.nhtsa.dot.gov/nhtsa/whatis/BB/2006/pages/AdminStmt.htm. [accessed May 11, 2011].

484 Insurance Institute for Highway Safety. *Safety Belt Use Laws.* Available at: http://www.iihs.org/laws/SafetyBeltUse.aspx [accessed May 22, 2011].

485 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. Traffic Safety Facts. *Seat Belt Use in 2010—Overall Results*. DOT HS 811 378.

Projected Impact

Occupant fatalities were 9 percent higher per vehicle-mile traveled and 15 percent higher per capita in 2005 and 2006 in states without primary seat belt laws.[486]

Economic Factors

Costs for implementing and enforcing primary seat belt laws are distributed among numerous enforcement agencies, and there is no breakdown of costs. Savings in medical and other costs if all states were to adopt primary seat belt laws would average $138 million per state annually.[487]

Conclusion

Universal adoption of primary seat belt laws would prevent hundreds of fatalities and thousands of injuries per year, resulting in billions of dollars in annual savings.

Policy 2—Increase funding for enhanced enforcement

Definition

Enhanced seat belt enforcement programs include defined periods of media coverage, intensive enforcement, paid advertisement, and program evaluations using observation surveys and surveys of public perception.[488]

History of Deployment

The largest enhanced enforcement campaign is the Click it or Ticket (CIOT) program, which utilizes advertising and funding provided by NHTSA. The first CIOT campaign took place in 1993. By 2004, most states and territories were participating in the program.[489]

Effectiveness Studies

Enhanced enforcement programs led to a median increase in observed seat belt use of 16 percentage points.[490]

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[486] U.S. Department of Transportation National Highway Traffic Safety Administration. 2006 Data. Traffic Safety Facts. *States With Primary Enforcement Laws Have Lower Fatality Rates.* DOT HS 810 557.

[487] National Cooperative Highway Research Program. 2008. *The Impact of Legislation, Enforcement, and Sanctions on Safety Belt Use*. Report No. 601.

[488] The Community Guide to Preventive Services. *Use of Safety Belts: Enhanced Enforcement Program.* Available at: http://www.thecommunityguide.org/mvoi/safetybelts/enforcementprograms.html [accessed May 22, 2011].

[489] U.S. Department of Transportation National Highway Traffic Safety Administration. C*ampaign History Fact Sheet*. Available at: http://www.nhtsa.gov/staticfiles/communications/pdf/ciot-history.pdf, [accessed June 5, 2010].

[490] The Community Guide to Preventive Services. *Use of Safety Belts: Enhanced Enforcement Program.* Available at: http://www.thecommunityguide.org/mvoi/safetybelts/enforcementprograms.html [accessed May 22, 2011].

Projected Impact

For each 1 percent increase in seat belt use, approximately 270 lives are saved annually.[491]

Economic Factors

Costs are moderate and vary by state.[492] Federal funding supports the CIOT campaign.[493]

Conclusion

Enhanced seat belt enforcement programs have proven very effective in increasing seat belt use, preventing thousands of traffic fatalities and hundreds of thousands of injuries. Maintaining and expanding federal funding for such programs will increase these benefits.[494]

3.6.3 Conclusions: Increase Seat Belt Use

Efforts have dramatically increased seat belt use from about 10 percent in 1982 to about 85 percent in 2010. However, there is a large potential for further gains by expanding federal incentive programs to encourage states without primary seat belt laws to establish and enforce such laws, and increasing federal funding for enhanced enforcement programs.

3.7 Increase Use of Age- and Size-Appropriate Child Safety Seats and Booster Seats

3.7.1 Background: Increase Use of Age- and Size-Appropriate Child Safety and Booster Seats

Prevalence of Use of Age- and Size-Appropriate Child Safety and Booster Seats

While there is evidence that more children are restrained in appropriate seats, especially among the youngest children, there is a strong tendency for children to be prematurely graduated out of rear-facing safety seats, out of front-facing safety seats, and into seat belts. Among the oldest and tallest children, only 15 percent were restrained in appropriate safety seats; by contrast, 89 percent of the shortest and youngest children were properly restrained.[495]

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491 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *Analyzing the First Years of the Ticket or Click It Mobilizations.* DOT HS 811 232.

492 Solomon, M.G., Ulmer, R.G., Presser, D.F. 2002. *Evaluation of Click It or Ticket Model Programs.* National Highway Traffic Safety Administration, DOT 809 498.

493 U.S. Department of Transportation National Highway Traffic Safety Administration. *Click It or Ticket: Campaign History Fact Sheet.* Available at: http://www.nhtsa.gov/CIOT [accessed April 13, 2011].

494 Ibid.

495 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Child Restraint Use in 2008 – Use of Correct Restraint Types.* DOT HS 811 132.

Impact on Fatality

Child safety seats reduce fatalities 71 percent for infants (less than a year) and 54 percent for toddlers (1 to 4 years).[496]

Potential for Lives Saved

In the United States, 1,314 children age 14 and under died in traffic crashes in 2009—at least 23 percent of those were unrestrained (not all children's restraint use was recorded). NHTSA estimates that 309 children age 5 and under were saved by restraint use in 2009. If child restraints had been used by all children age 5 and under involved in fatal crashes, an additional 63 lives could have been saved.[497] Adjusting the use of child restraints to ensure they are age- and size-appropriate would save at least a similar number of lives.[498]

Policies for Increasing Use of Age- and Size-Appropriate Child Safety and Booster Seats

The current rate of non-use or misuse of child restraint systems is surprisingly high. Two policies are described for increasing the use of appropriate child restraints.

Policy 1: Encourage states to adopt and enforce uniform standards

Policy 2: Increase funding for education and enforcement

3.7.2 Impact of Policies: Increase Use of Age-Appropriate Child Safety and Booster Seats

Policy 1— Encourage states to adopt and enforce uniform standards

Definition

From infancy to pre-teen years there are four types of appropriate restraints: (1) rear-facing child safety seats, (2) forward-facing child safety seats, (3) booster seats, and (4) adult seat belts. NHTSA publishes detailed guidelines for appropriate use based on age and weight of the child.[499]

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[496] U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Occupant Protection*. DOT HS 811 160.

[497] U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Children*. DOT HS 811 387.

[498] U.S. Department of Transportation National Highway Traffic Safety Administration. 1999. *Final Economic Assessment, FMVSS No.213 and 225, Child Restraint Systems, Child Restraint Anchorage Systems*, Office of Regulatory Analysis. Available at: http://www.nhtsa.gov/cars/rules/rulings/ucra-omb-j08/econ/regeval.213.225.html [accessed May 21, 2011].

[499] U.S. Department of Transportation National Highway Traffic Safety Administration. 2011. *Child Safety*: *Which Car Seat is the Right One for Your Child?* Available at: http://www.nhtsa.gov/Safety/CPS [accessed May 21, 2011].

History of Deployment

NHTSA, in particular, has developed guidelines and recommendations for child restraint devices.[500,501] Federal rules in this area were strengthened in 2002 with the adoption of LATCH (Lower Anchors and Tethers for Children), a system mandated for nearly all passenger vehicles and all child safety seats in an effort to standardize and simplify the installation of child restraint systems. While all 50 states and the District of Columbia currently have child restraint laws in effect, requirements differ, with many falling short of offering the best protection—and three states have no booster seat use requirement.

In March of 2011, NHTSA released new guidelines based on age to help parents choose the appropriate restraints for their children.[502] However, many parents still prematurely "graduate" their children to older-child restraints.[503,504]

Effectiveness Studies

Education and training programs increase child restraint device use.[505] Research is needed on the potential impact of setting and enforcing uniform standards.

Projected Impact

There has been little study on the impact of standardized regulations of child protection systems on parents' ability to use them more appropriately. Research on parents' perceptions, as well as the implications such standards would have for simplifying and improving enforcement, would contribute to an understanding of the effectiveness of this policy.

Economic Factors

There is little information on the cost of adopting and enforcing uniform standards on a national basis. Given the high impact that any improvement in use rates would have, any steps to make compliance easier for parents are likely to lead to significant safety gains and cost savings. NHTSA has been giving states incentive grants to improve compliance and enforcement.[506]

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500 U.S. Department of Transportation National Highway Traffic Safety Administration. 2009.Traffic Safety Facts. *Child Restraint Use in 2008 Use of Correct Restraint Types.* DOT HS 811 132.

501 U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *Child Safety*.

502 U.S. Department of Transportation National Highway Traffic Safety Administration. 2011. *Child Safety*: *Which Car Seat is the Right One for Your Child?* Available at: http://www.nhtsa.gov/Safety/CPS [accessed May 21, 2011].

503 Rivara, F.P., Bennett, E., Crispin, B., Kruger, K., Ebel, B. and Sarewitz, A. 2001. Booster seats for child passengers: lessons for increasing their use. *Injury Preventio,n* 7: 210-213.

504 Ramsey, A., Simpson, E. and Rivara, FP. 2000. Booster Seat Use and Reasons for Nonuse. *Pediatrics.* American Academy of Pediatrics. 106 (2): e20.

505 Tessier, Karen 2010. Effectiveness of Hands-On Education for Correct Child Restraint Use by Parents. *Accident Analysis and Prevention*, 1041-1047.

506 Federal Grants Wire. *Child Safety and Child Booster Seats Incentive Grants (20.613).* Available at: http://www.federalgrantswire.com/child-safety-and-child-booster-seats-incentive-grants.html [accessed May 23, 2011].

Conclusion

Encouraging states to adopt national standards through incentive programs is likely to reduce traffic deaths and injuries among child passengers.

Policy 2—Increase funding for education and enforcement

Definition

Education and enforcement programs combine high-visibility media campaigns with well-publicized enforcement efforts to raise awareness.

History of Deployment

In the 1990s, NHTSA led the development of a standardized curriculum for child passenger safety education, which includes a process for training and certifying persons in how to correctly install child safety devices. In addition, NHTSA and its many partners each year conduct Child Passenger Safety Week and National Seat Check Saturday, during which parents and caregivers are offered free inspections of their child safety seats and are provided education on correct installation and use.[507,508]

Effectiveness Studies

Education and enforcement increase child protection device use by a median 23 percent.[509] Education programs that incorporate incentives or rewards are the most effective.[510] Checkpoints increase child seat effectiveness by 21 percent.[511,512]

Projected Impact

There is little information on the impact of education and enforcement programs, though they have been shown to work. Additional study of the effectiveness of different approaches would aid the design of more effective policies.

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[507] U.S. Department of Transportation National Highway Traffic Safety Administration. 2009. Traffic Safety Facts. *Child Restraint Use in 2008—Use of Correct Restraint Types.* DOT HS 811 132.

[508] U.S. Department of Transportation National Highway Traffic Safety Administration. 2010. *Child Safety Seat Inspection Station Locator*.

[509] The Community Guide to Preventive Services. 2010. *Use of Child Safety Seats: Distribution and Education Programs*. Available at: http://www.thecommunityguide.org/mvoi/childsafetyseats/distribution.html [accessed September 17, 2010].

[510] Zaza, S., Sleet, D.A., Thompson, R.S., Sosin, D.M., Bolen, J.C. and Task force on Community Preventive Services. 2001. Reviews of Evidence Regarding Interventions to Increase the Use of Child Safety Seats. *American Journal of Preventive Medicine*, 21 (4S): 31-47.

[511] Decina, L.E., Hall, W.L. and Lococo, K.H. 2010. *Booster Seat Law Enforcement: Examples from Delaware, New Jersey, Pennsylvania and Washington.* National Highway Traffic Safety Administration. DOT HS 811 247.

[512] Miller, T. R., Zaloshnja, E. and Sheppard, M.A. 2002. *Child Safety Distribution & Misuse Reduction Programs Sound Investments?* Paper presented at the 130th Annual Meeting of the American Public Health Association, Philadelphia, PA.

Economic Factors

Given the relatively low expense, child safety seat programs for education or enforcement are highly cost-effective.[513] NHTSA has provided consistent although limited funding for such programs for some time.[514]

Conclusion

Even when parents select the appropriate child safety seat, improper installation or misuse is common.[515] Increased funding for parent and community education, as well as increased enforcement, are likely to increase the age- and size-appropriate use of child restraint systems.[516]

3.7.3 Conclusions: Increase Use of Age-Appropriate Child Safety Seats and Booster Seats

There is considerable room for improvement in the rate of use of child restraints that provide the most protection for children based on their size and age. Giving incentives for states to adopt uniform child restraint laws and increasing funding for education and enforcement are very likely to increase appropriate child restraint use and prevent child passenger fatalities and injuries.

3.8 Conclusions for Chapter 3

Motor vehicle crashes are the leading cause of fatality and injury for Americans age 1 to 34. In 2009, traffic-related crashes resulted in 33,808 deaths and over 2 million injuries.

DUI crash fatalities decreased from 53 percent all traffic fatalities in 1982 to 32 percent in 2009 largely due to governmental policies. Significant additional savings in lives and dollars could be achieved through expanding interlock programs, increasing the use of sobriety checkpoint programs, maintaining the minimum drinking age law at 21 and expanding enforcement, and strengthening the implementation and enforcement of zero-tolerance laws for underage drivers.

Distracted driving increases crash risk—in the case of cell phone use, to rates approximating those for DUI. Three policies at the federal level have potential for reducing this risk: incentive grants to states to pass rigorous and effective bans on cell phone use, grants to support high-visibility enforcement of cell phone bans, and support for distracted driving education programs in conjunction with enforcement.

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513 Ibid.

514 United States Department of Transportation. 1998. *TEA-21: A Summary – Improving Safety*. Available at: http://www.fhwa.dot.gov/Tea21/sumsafe.htm [accessed September 17, 2010].

515 Decina, L.E., Lococo, K.H. and Block, A.W. 2005. *Misuse of Child Restraints: Results of a Workshop to Review Field Data Results.* Traffic Safety Facts, Research Note. National Highway Traffic Safety Administration. DOT HS 809 851.

516 Pierce, S.E., Mundt, M.P., Peterson, N.M. and Katcher, M.L. 2005. Improving Awareness and Use of Booster Seats in Head Start Families. *Wisconsin Medical Journal* 104 (1): 46-51.

Both younger (age 21 and under) and older (age 65 and over) drivers experience disproportionately high rates of fatalities and traffic crash risks. Graduated driver licensing (GDL) laws benefit younger drivers, while ensuring compliance and strengthening testing and restriction can further reduce youth fatalities. Although limited research has been conducted regarding implementation of driver assessment programs for older drivers, findings suggest that they reduce crash and fatality risks.

Speeding is a very common behavior and a major contributor to traffic crashes. Automated speed enforcement (ASE) is very effective at cutting speeds and fatalities, but it faces public resistance unless it is deployed as a revenue-neutral safety measure designed around the principals of general deterrence. Traffic calming can be effective on the local level, especially for pedestrian and bicycle safety.

Seat belt use has increased from about 10 percent in 1982 to about 85 percent in 2010, due to efforts over the past several decades, preventing thousands of fatal and non-fatal injuries. However, there is great potential for further gains if the national rate were to be raised to 90 percent overall. Expanding federal incentive programs to encourage states to adopt and enforce primary seat belt laws and maintaining and increasing federal funding for enhanced enforcement and education programs would result in additional savings of thousands of lives and injuries and billions in associated yearly costs.

While more children are being properly restrained, misuse is still a major problem, especially among children age 1 and above. Giving states incentives to adopt uniform child restraint laws and usage standards, while increasing funding for education and enforcement is likely to increase appropriate child restraint usage and reduce traffic fatalities and injuries among child passengers.