AMERICAN JOURNAL OF
PREVENTIVE
MEDICINE

Supplement to American Journal of Preventive Medicine November 2001

The Guide to Community Preventive Services

Reducing Injuries to Motor Vehicle Occupants

Systematic Reviews of Evidence, Recommendations from the Task Force on Community Preventive Services, and Expert Commentary

Guest Editors

Stephanie Zaza and Robert S. Thompson

Guest Coordinating Editor

Kate W. Harris

A Journal of the

ACPM
American College of Preventive Medicine
&
ATPM
Association of Teachers of Preventive Medicine

ELSEVIER
ISSN 0749-3797

In a plea for state cooperation to reduce injuries to motor vehicle occupants, President Franklin D. Roosevelt sent this historic letter to the Governors of the forty-eight states.

January 23, 1935.

Honorable Eugene Talmadge,
Governor of Georgia,
Atlanta, Georgia.

My dear Governor Talmadge:

I am gravely concerned with the increasing number of deaths and injuries occuring in automobile accidents. Preliminary figures indicate that the total of these losses during the year 1934 greatly exceeded that of any previous year. We should, as a people, be able to solve this problem which so vitally affects the lives and happiness of our citizens.

In order to assist in this, the Federal Government, through the Secretary of Commerce, has taken the leadership in developing remedial measures. Proposals for uniform State legislation have been worked out by the National Conference on Street and Highway Safety with the cooperation of responsible State officials and representatives of interested organizations from all parts of the country.

The remedies that need to be applied are thus available in form which appears to meet the unanimous approval of experienced judgment. The pressing problem is to secure universal application of these remedies which have proved effective where applied.

The responsibility for action rests with the States. There is need for legislation and for the organization of proper agencies of administration and enforcement. There is need also for leadership in education of the public in the safe use of the motor vehicle, which has become an indispensable agency of transportation.

With the legislatures of most of the States meeting during 1935, concerted effort for appropriate action in the States is most important.

Realizing the seriousness of the situation and the urgent need for attention to the problem, I am confident that you will desire to participate in this effort.

Yours very truly,

FRANKLIN D. ROOSEVELT

We acknowledge the assistance of Dr. David Sleet and Ms. Joanna Taliano of the CDC and Archivists Bob Clark and Dr. Raymond Teichman of the Franklin D. Roosevelt Library for finding and documenting this letter.

AMERICAN JOURNAL OF PREVENTIVE MEDICINE

A forum for the communication of information, knowledge, and wisdom in prevention science, education, practice, and policy.

A Journal of the
ACPM
American College of Preventive Medicine
&
ATPM
Association of Teachers of Preventive Medicine

Published by
Elsevier Science Inc.

Editorial correspondence and submissions should be directed to:

Editor
American Journal of Preventive Medicine
San Diego State University
5500 Campanile Drive
San Diego, CA 92182-4710
Tel (619)594-7344
Fax (619)594-5613
e-mail ajpm@mail.sdsu.edu

AJPM Online
www.elsevier.com/locate/ajpmonline

AJPM Home Page
www.elsevier.com/locate/amepre

Sponsoring Organizations' Offices:

American College of Preventive Medicine
Jordan H Richland, MPH, MPA
Executive Director
1307 New York Avenue, NW,
Suite 200
Washington, DC 20005
Tel (202)466-2044
Fax (202) 466-2662
website www.acpm.org

Association of Teachers of Preventive Medicine
Barbara J Calkins, MA, CAE
Executive Director
1660 L St. NW, Suite 208
Washington, DC 20036-5603
Tel (202)463-0550
Fax (202) 463-0555
website www.atpm.org

Author's Instructions on AJPM's Website

Complete author's instructions and guidelines for submitting manuscripts to the **American Journal of Preventive Medicine** can be found in each January issue and on the **AJPM Online Website:** *www.elsevier.com/locate/ajpmonline.* The Journal welcomes brief reports (max. 1200 words), research articles (2500–2750 words), and review articles (max. 4000 words) on all aspects of practice, education, policy, and research in preventive medicine and public health.

The American Journal of Preventive Medicine (ISSN 0749-3797), the official journal of the American College of Preventive Medicine and the Association of Teachers of Preventive Medicine, is published eight times a year, monthly except in March, June, September, and December, by Elsevier Science Inc., 655 Avenue of the Americas, New York, NY 10010, USA.

Subscriptions are available on a calendar-year basis. The annual rates (Volumes 22–23, 2002—8 issues) for Customers in Europe and the CIS: Institutional rate EUR 356.00; Personal rate EUR 138.00. For Customers in Japan: Institutional rate: JPY 47,200.00; Personal rate: JPY 18,400.00. For Customers in all other Countries: Institutional rate US$398.00; Personal rate US$155.00. Single issues are available on request from your nearest Regional Sales Office. All prices include postage.

FOR ADVERTISING ORDERS & INQUIRIES: **North & South America:** Hank Blaney, Elsevier Science Inc., 655 Avenue of the Americas, New York, NY 10010; Tel (212) 633-3648; Fax (212) 633-3820; E-mail: h.blaney @elsevier.com **International:** Advertising Department, Elsevier Science, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom; Tel (+44) (0) 1865 843565; Fax (44) (0) 1865 843976; E-mail: media@elsevier.co.uk **Japan:** Advertising Department, Elsevier Science Japan; Tel (81) (3) 5561 5033; Fax (81) (3) 5561 5047.

Personal rates apply only when issues of the journal are sent to a private address and payment is made by personal check or credit card. Any enquiry relating to subscriptions should be sent to: **The Americas:** Elsevier Science, Customer Support Department, P.O. Box 945, New York, NY 10010, USA (Tel: (+1) 212-633-3730/1-888 4ES-INFO. Fax: (+1) 212-633-3680. E-mail: usinfo-f@elsevier.com). **Japan:** Elsevier Science Customer Support Department, 9-15 Higashi-Azabu I-chome, Minato-ku, Tokyo 106, Japan (Tel: (+3) 5561-5033. Fax (+3) 5561-5047. E-Mail: kyf04035@nifty-serve-.or.jp). **Asia Pacific *(excluding Japan)*:** Elsevier Science (Singapore) Pte Ltd, No. 1 Temasek Avenue, 17-01 Millenia Tower, Singapore 039192. (Tel: (+65) 434-3727. Fax: (+65) 337-2230. E-mail: Asiainfo@elsevier.com.sg). **Brazil:** Elsevier Science, Rua Sete de Setembro 111/16 Andar, 20050-002 Centro, Rio de Janeiro-RJ, Brazil (Tel: (+55) (21) 509 5340. Fax: (+55) (21) 507 1991. E-mail: elsevier@campus.com.br). **Rest of the World:** Elsevier Science Customer Service Department, P.O. Box 211, 1001 AE Amsterdam, The Netherlands. (Tel: (+31)20-485-3757. Fax: (+31) 20-486-3432. E-mail: nlinfo-f@elsevier.nl).

The American Journal of Preventive Medicine is indexed and abstracted in Index Medicus/MEDLINE, EMBASE/Excerpta Medica, MEDLARS, Psychological Abstracts, PsycINFO, Sociological Abstracts, the Health Promotion and Education and the Cancer Prevention and Control Databases of CHID on BRS, and the Smoking and Health Database on DIALOG.

POSTMASTER: Send address changes to the American Journal of Preventive Medicine, Elsevier Science Inc., 655 Avenue of the Americas, New York, NY 10010. Periodicals postage paid at New York, NY and additional mailing offices.

The journal is printed on acid-free paper that meets the minimum requirements of ANSI Standard Z39.48-1984 (Permanence of Paper), beginning with volume 1, number 1.

AMERICAN JOURNAL OF
PREVENTIVE MEDICINE

VOLUME 21 NOVEMBER 2001 NUMBER 4S

A Journal of the
ACPM
American College of Preventive Medicine
&
ATPM
Association of Teachers of Preventive Medicine

Published by
Elsevier Science Inc.

Acknowledgment

This work was supported by funds from the National Center for Injury Prevention and Control (NCIPC), Centers for Disease Prevention and Control (CDC); the National Highway Traffic Safety Administration (NHTSA); and the Division of Prevention Research and Analytic Methods, Epidemiology Program Office, CDC. The editors and guest editors thank each of the authors and their respective institutions for the unflagging efforts to review, recommend, and comment on this vital topic. We also wish to thank Sandra Bonzo and Joanna Taliano, Research Librarians, for their hard work; Bruce H. Jones, Leader, Motor Vehicle Team, NCIPC, for his guidance throughout the process; and our reviewers for their helpful comments.

The Task Force on Community Preventive Services and the staff of the Community Guide Branch at CDC would like to thank Dr. Jeffrey R. Harris, former director of the Division of Prevention Research and Analytic Methods, for his outstanding leadership and constant advocacy for the *Guide to Community Preventive Services* project over the past three years. Dr. Harris is currently with the School of Public Health and Community Medicine at the University of Washington, Seattle.

The Task Force on Community Preventive Services and the Centers for Disease Control and Prevention gratefully acknowledge the contributions and leadership of the outgoing Task Force chair, Dr. Caswell A. Evans, Jr. Dr. Evans chaired the Task Force from its inception in 1996 until mid-2001, when he became Director of the National Oral Health Initiative in the Office of the U.S. Surgeon General. Today's Task Force is that much better for his steady and even-handed guidance.

TASK FORCE ON COMMUNITY PREVENTIVE SERVICES

Members (October 1, 2001):

Jonathan E. Fielding, MD, MPH, MBA (Chair)
Los Angeles Department of Health Services
Los Angeles, California

Patricia Dolan Mullen, DrPH (Vice Chair)
University of Texas–Houston School of Public Health
Houston, Texas

Ross C. Brownson, PhD
St. Louis University School of Public Health
St. Louis, Missouri

Mindy Thompson Fullilove, MD
New York State Psychiatric Institute and Columbia University
New York, New York

Fernando A. Guerra, MD, MPH
San Antonio Metropolitan Health District
San Antonio, Texas

Alan R. Hinman, MD, MPH
Task Force for Child Survival and Development
Atlanta, Georgia

George J. Isham, MD
HealthPartners
Minneapolis, Minnesota

Garland H. Land, MPH
Center for Health Information Management and Epidemiology
Missouri Department of Health
Jefferson City, Missouri

Charles S. Mahan, MD
College of Public Health
University of South Florida
Tampa, Florida

Patricia A. Nolan, MD, MPH
Rhode Island Department of Health
Providence, Rhode Island

Susan C. Scrimshaw, PhD
School of Public Health
University of Illinois
Chicago, Illinois

Steven M. Teutsch, MD, MPH
Merck & Company, Inc.
West Point, Pennsylvania

Robert S. Thompson, MD
Department of Preventive Care
Group Health Cooperative of Puget Sound
Seattle, Washington

Consultants:

Robert S. Lawrence, MD
Bloomberg School of Public Health
Johns Hopkins University
Baltimore, Maryland

J. Michael McGinnis, MD
Robert Wood Johnson Foundation
Princeton, New Jersey

Lloyd F. Novick, MD, MPH
Onondaga County Department of Health
Syracuse, New York

Former Members:

Patricia A. Buffler, PhD, MPH (1996–2000)
School of Public Health
University of California, Berkeley

Mary Jane England, MD (1996–2001)
Washington Business Group on Health
Washington, DC
Current affiliation: Regis College
Weston, Massachusetts

Caswell A. Evans, Jr., DDS, MPH (1996–2001)
Los Angeles County Department of Health Services
Los Angeles, California
Current affiliation: Director, National Oral Health Initiative
Office of the U.S. Surgeon General
Rockville, MD

David W. Fleming, MD (1996–2000)
Oregon Health Division
Department of Human Resources
Portland, Oregon
Current affiliation: Centers for Disease Control and Prevention
Atlanta, Georgia

Foreword

Note from the Surgeon General

At the intersection of public health and transportation safety is the concern for reducing injuries to motor vehicle occupants. Progress in motor vehicle injury prevention stands out as one of the ten significant public health achievements of the 20th Century.[1] Although six times as many Americans drive today as did in 1925, covering ten times as many miles in eleven times as many vehicles, the annual death rate from motor vehicle crashes has decreased 90%. Yet approximately 40,000 Americans of all ages still die each year as a result of motor vehicle trauma. Motor vehicle crashes are not "accidents," and much can be done to prevent them and the injuries that result.

Safety and injury prevention must be among our highest public health priorities as a nation. Our national commitment to reducing injuries and deaths from motor vehicle crashes, especially those involving alcohol-impaired driving and failure to use seat belts and child safety seats, are important objectives in *Healthy People 2010*[2]—our nation's prevention agenda for the next 10 years. With these objectives in mind, the authors present the results of years of work in summarizing the scientific evidence and preparing a set of recommendations to further reduce injuries among motor vehicle occupants. The systematic reviews of evidence and recommendations appearing in this supplement to the *American Journal of Preventive Medicine* (AJPM) address interventions to increase child safety seat use, increase safety belt use, and reduce alcohol-impaired driving. The recommendations from the Task Force on Community Preventive Services (the Task Force) emphasize that no one strategy will address all the underlying causes of motor vehicle crashes and the resulting death and disability. Decision makers at the federal, state, and local levels should seek to implement a variety of strategies to reduce motor vehicle crashes and their often tragic consequences.

Motor vehicle crashes are the leading cause of death of children in the United States. No more important challenge exists than finding ways to improve the safety of our children, and proper restraint while riding in motor vehicles can be the single most effective approach. These systematic reviews provide strong scientific evidence of the effectiveness of both child safety seat laws and campaigns to educate and enforce these laws conducted at the state and local levels. Although the recommendations do not specifically address booster seat use, finding ways to increase booster seat use, which may be as low as 10%, is also vital. Initiatives at the federal level to raise safety seat use include partnerships with states and local communities, as well as manufacturers and professional groups. These activities include distribution programs to help low-income families, development of better restraints, sponsorship of fitting stations to promote proper installation and use of both safety seats and booster seats, and enhanced enforcement of child safety seat laws. To ensure progress, evaluating these efforts will be critical.

Safety belt use now exceeds 70% nationally, but too many people are needlessly injured or killed because they do not buckle their safety belts and those of their children. The Task Force's recommendations and the scientific reviews in this supplement point to the effectiveness of strong safety belt laws and enhanced enforcement of existing laws to increase safety belt use.

Healthy People 2010 calls for reducing alcohol-related motor vehicle fatalities to 4 people per 100,000, a reduction of more than 30% from current levels. To meet the goal, we must apply comprehensive approaches to curtail impaired driving, community by community, state by state. This supplement sets forth strategies to help strengthen laws that target alcohol-impaired driving. For example, based on the evidence, the Task Force strongly recommended that states adopt a law reducing the limit for blood alcohol concentration (BAC) to .08%. The Fiscal Year 2001 Department of Transportation and Related Agencies Appropriations Act put this recommendation into practice by requiring states to adopt .08% BAC laws by October of 2003 or lose a portion of their highway funds.

It is my pleasure to congratulate the Task Force, the Centers for Disease Control and Prevention scientific staff, authors, team members, and collaborators who conducted the systematic reviews for their dedication and determination. I especially want to thank the outgoing Chair of the Task Force, Dr. Caswell Evans, Jr., for his leadership of and commitment to the development of the *Guide to Community Preventive Services* since the inception of this initiative in 1996. I also want to thank again the Journal's

Address correspondence and reprint requests to: Stephanie Zaza, MD, MPH, Centers for Disease Control and Prevention, MS K-73, Epidemiology Program Office/DPRAM, 4770 Buford Highway, Atlanta, GA 30341. E-mail: sxz2@cdc.gov.

editors for their interest in publishing and promoting these recommendations and reviews.

Effective public health policy must be based on sound scientific evidence. These findings provide that evidence, thereby expanding and solidifying the knowledge needed for informed decision making that can improve the health of every citizen. This knowledge adds to a growing body of evidence developed by the Task Force as part of the *Guide to Community Preventive Services*, which will be useful to decision makers as a standard reference for identifying what works at a population level to improve health. I encourage decision makers at the state and local levels to use the findings presented in this special issue of the AJPM to develop strategies to meet the needs of their communities. I am confident that this publication will be a major milestone toward the goal of motor vehicle occupant injury prevention and will build new opportunities for greater national success.

David Satcher, MD, PhD
Surgeon General of the United States

References

1. Centers for Disease Control and Prevention. Motor vehicle safety: a 20th century public health achievement. MMWR 1999;48:369–73.
2. U.S. Department of Health and Human Services. Healthy People 2010 (conference edition, in 2 vols.). Washington, DC: U.S. Department of Health and Human Services, 2000.

Commentary

Public Health's Contribution to Motor Vehicle Injury Prevention

Patricia F. Waller, PhD

This supplement to the *American Journal of Preventive Medicine* addresses interventions that were considered impossible a quarter of a century ago. Drunk driving was considered more or less a "folk crime," almost a rite of passage for young males. Most adults in the United States used alcohol, and most of them, at some point, drove after doing so. This is not to say that they drove drunk, but many of them undoubtedly drove when they were somewhat impaired. Although the law provided for fairly harsh penalties, they were rarely applied. Upon arraignment, defendants would ask for a jury trial, and because drinking and driving was so widespread, juries almost invariably acquitted the defendant, thinking, "There but for the grace of God go I."

Seat belt laws were rejected out of hand by legislators as well as many in the research community. Although other industrialized nations were enacting them, it was widely agreed in the United States that we would never tolerate such imposition on personal freedom.

Today, we have laws and programs that have reduced drinking and driving, increased occupant restraint use, and had a major role in reducing motor vehicle injury and death. If we were still experiencing motor vehicle fatalities at the 1966 rate, based on vehicle miles driven, we would have had about 147,000 such deaths in 1999 rather than the 41,611 that actually occurred.[1] The dramatic reductions in motor vehicle crash injury and death represent a major public health achievement.[2,3] What has made the difference?

The research community was generating evidence on drinking and driving long before changes occurred in public policy. In 1904, in the *Journal of Inebriety*, an editorial noted the danger of drinking drivers of "automobile wagons," and recommended that, as in the case of locomotives, only abstainers be allowed to operate these vehicles.[4] In the 1930s, research indicated that drinking drivers were more likely to be involved in crashes[5]; and in 1964, the Grand Rapids study[6] clearly demonstrated the elevation in crash risk as blood alcohol concentration increased. Other studies followed, and a wealth of information was generated, showing the hazards associated with driving after drinking.

The evidence on occupant restraints began accumulating almost as soon as safety belts were first available in passenger vehicles. As other nations enacted legislation and belt usage rose, the data clearly showed the life-saving effects. Even so, in this country little was done to translate findings into legislation and enforcement. Legislators were presented with what we in the academic community considered convincing evidence, and were told, "Is that all you have? I could never get this out of committee!" It was easy to become discouraged.

It was citizen action groups that provided the impetus for major changes in public policy governing drinking and driving. Their activities generated public support for enforcement of existing laws and enactment of new ones. Research findings were translated into laws and programs. Something similar, although perhaps not so dramatic, occurred in the case of occupant restraints. The first major changes in the United States addressed the safety of infants and small children, where it was more difficult to argue that they should decide for themselves whether to be safely restrained. Although infants were never a large part of the annual toll, they were recognized as a population worthy of protection (i.e., they were not guilty of speeding, drinking, or otherwise behaving irresponsibly). Because of the determination of a public health physician, Robert Sanders, Tennessee became the first jurisdiction in the world to enact legislation requiring that infants and small children be properly restrained while transported in motor vehicles. This legislation was eventually enacted in all 50 states, and was gradually extended to older children and adults. Again, citizen organizations actively promoted these changes. The research community monitored the programs and reported to legislators and the public. Today, all but one state have laws requiring belt use for at least some vehicle occupants.[7]

Data alone were not sufficient to bring about major changes in policies affecting individual behavior. Success is attributable to a wide range of participants, including legislative, enforcement, judicial, public health, medical, and public organizations and advocates. The individual and community actions that re-

Dr. Waller is former Director, University of Michigan Transportation Research Institute (UMTRI); and former Director, University of North Carolina Highway Safety Research Center.

Address correspondence to: Patricia F. Waller, PhD, 1779 Crawford Dairy Road, Chapel Hill, NC 27516. E-mail: pwaller@umich.edu.

PII S0749-3797(01)00386-5

sulted were fostered by education, stimulated by social norms, and encouraged through public policy, and are examples of the value of taking a health promotion approach to motor vehicle injury prevention.[8,9] However, the incredible progress experienced could not have come about in the absence of sound evidence from the research community. Good data are necessary, even if not sufficient. (This author would argue that data should not be the sole basis on which public policy decisions are made. Such decisions should be made by those who must answer to the voters, and who must take into account other concerns, e.g., cost, infringement on individual rights. Although it is clear that under even the best of circumstances, motorcycles are dangerous, we are not prepared to outlaw their use.)

Remarkable progress has been made, but 41,000 deaths annually are still far too many. While efforts continue in addressing drunken driving and occupant restraint use, new opportunities are developing with the advent of Intelligent Transportation Systems (ITS). ITS is the application of communications and other technologies to the transportation system. The primary purpose of transportation is to gain access to those goods and services needed for optimal development of individual and community potential. ITS technologies hold promise for greatly enhancing the safety and efficiency of gaining such access.[10] Vehicles and roadways are being equipped to present more and better information to roadway and transit users, in some instances even taking over the driving task to avoid collisions. Real-time information on highway congestion and incidents is provided to drivers, and transit availability and routing is provided to transit users.

There remains a crucial need for support for training new researchers in this field. Of particular importance is the participation of the academic community, both to provide well-conducted research to generate new information and to educate students about this major public health problem. Such education is important not just for those who will enter the field directly, but also for those who will influence policy affecting the implementation of countermeasures. There is no question that today's public is better informed about and more aware of the dimensions of the motor vehicle injury problem. The momentum that has been generated over the past 30 years must be maintained.

When the federal highway safety program was created in 1966, a cadre of researchers became involved. In real dollars, funding subsequently shrank. Many left the field, and there was little support for recruiting new investigators. As a result, much of the leadership is retired or reaching retirement, leaving a "missing generation" needed to take over. This experience underscores the importance of ongoing public support for educating students and sustaining research careers.[11] The CDC's National Center for Injury Prevention and Control is playing the major role in developing and sustaining researchers in injury prevention—a role that must clearly continue.[12] The benefits to society from the public investment in research and training in this field are enormous in both human and monetary terms. With over 41,000 deaths annually, motor vehicle crashes remain a major preventable public health problem. Implementation of the recommendations in this supplement holds the promise of further reducing what remains an unacceptable toll.

References

1. National Highway Traffic Safety Administration. Traffic Safety Facts 1999: overview. DOT HS 809 092.
2. Centers for Disease Control and Prevention. Motor vehicle safety: a 20th century public health achievement. MMWR 1999;48:369–74.
3. CDC. National Center for Injury Prevention and Control. Prevention of motor vehicle-related injuries: a compendium of articles from the Morbidity and Mortality Weekly Reports, 1985–1996. Atlanta, GA: Centers for Disease Control and Prevention, 1997.
4. U.S. Department of Transportation: Alcohol and Highway Safety. Report to the US Congress 1968. Washington, DC: US Government Printing Office. Quoted in: Jones RD, Joscelyn KD. Alcohol and highway safety, 1978: Review of the state of knowledge. Washington, DC: National Highway Traffic Safety Administration; 1978:1–2. DOT HS 803-714.
5. Holcomb RL. Alcohol in relation to traffic accidents. JAMA 1938;111:1076–85.
6. Borkenstein RF, Crowther RF, Shumate RP, Ziel WB, Zylman R. The Role of the Drinking Driver in Traffic Accidents. Bloomington, IN: Indiana University, Department of Police Administration, 1964.
7. National Highway Traffic Safety Administration. Traffic Safety Facts 1999: Occupant Protection. DOT HS 809 090. Washington, DC: National Highway Traffic Safety Administration, 2000.
8. Sleet DA, Wagenaar AC, Waller PF. Introduction: drinking, driving, and health promotion. Health Ed Q 1989;16:329–34.
9. Tolsma DD. Health promotion approaches to occupant protection: an epidemiologic framework. Health Ed Q 1984;11:133–40.
10. Waller PF. Transportation to meet societal needs. ITS Q 1998;6:5–11.
11. Committee on Injury Prevention and Control. Reducing the Burden of Injury. Washington, DC: National Academy Press, 1999.
12. Sleet DA, Bonzo S, Branche C. An overview of the National Center for Injury Prevention and Control at the CDC. Injury Prev 1998;4:308–12.

Motor Vehicle Occupant Injury Prevention
The States' Perspective

John Moffat

Among public health issues, the safety of motor vehicle occupants is probably the issue that touches closest to home. Motor vehicle travel is the primary means of transportation in the United States. Sadly, although a broad collaboration of vehicle safety advocates at the federal, state, and community levels have worked to improve the safety of vehicles and to protect vehicle occupants, motor vehicle crashes are the leading cause of death for every age from 1 through 34 years. There is clearly much more to be done to promote vehicle occupant safety and to reduce the numbers of fatalities and injuries resulting from motor vehicle crashes. As early as 1935, President Franklin D. Roosevelt made a plea for the governors of each state to become involved in this issue (see inside front cover of this supplement).

The findings presented by the Task Force on Community Preventive Services (the Task Force) in this supplement[1–3] to the *American Journal of Preventive Medicine* support and provide a strong research-based justification for the many efforts that are being conducted by states to increase motor vehicle occupant safety. They also support the call by the National Association of Governors' Highway Safety Representatives (NAGHSR) to implement a broad range of prevention strategies and, in addition to legislation, to use the other effective tools that we have at our disposal. NAGHSR represents State Highway Safety Offices, and its members are responsible for developing and implementing annual state highway safety plans.

In the area of increasing child safety in vehicles, for example, recent efforts have focused on the ranking of child passenger safety laws. However, it is important to recognize that legislation alone is not a "magic bullet," but only part of the solution. As the Task Force points out,[1] community-wide information and enforcement campaigns are important adjuncts to laws to increase child safety seat use and reduce injuries among children. Many states are using public awareness and enforcement campaigns, fitting stations, child restraint distribution, loaner programs, and education programs to complement laws. NAGHSR is committed to encouraging all states to pursue a range of strategies to ensure child passenger safety, including fostering additional research and outreach about the use of booster seats. Under the auspices of the Ford Motor Company's *Boost America!* Campaign, and with the endorsement of NAGHSR, the National Highway Traffic Safety Administration (NHTSA), and a variety of other safety, health, and law enforcement organizations, educational materials have been distributed to parents and caregivers about the importance of booster seat use, and one million booster seats will be distributed to families in need and to Ford customers. *Boost America!* represents the type of broad public/private partnerships that are needed to achieve greater child safety in vehicles. The recommendations from the Task Force identify effective tools for such partnerships to use in building child passenger safety programs.

Another finding strongly supported by NAGHSR is that primary safety belt laws, especially when complemented by enhanced enforcement efforts, do save lives. The evidence presented by the Task Force[2] shows that primary seatbelt laws should be passed in every state. State Highway Safety Offices can educate lawmakers and the general public on this issue by providing information and resources, such as the evidence published here, which can be the catalyst for primary legislation. For example, Delaware, New Jersey, and South Carolina—among many others—have featured collaborations between State Highway Safety Offices and statewide coalitions to provide legislatures with testimony and research materials supporting primary laws, as well as working to secure sponsorship and support for passage of such laws. State Highway Safety Offices know how essential seatbelt use is, and they will continue to make sure that the public realizes the lifesaving choices it can make by buckling up.

The third component of highway safety addressed by the Task Force—alcohol-impaired driving[3]—is probably the most pervasive problem facing State Highway Safety Offices. NAGHSR members work to prevent impaired driving, including underage drinking and driving, through improvements on state laws, educational programs, community efforts, public information campaigns, and the enforcement of laws aimed against impaired driving. NAGHSR recently released a

From the National Association of Governors' Highway Safety Representatives, Washington, DC

Address correspondence and reprint requests to: John Moffat, Chair, National Association of Governor's Highway Safety Representatives, 750 First Street NE, Suite 720, Washington, DC, 20002-4241. Website: www.statehighway.org.

0749-3797/01/$–see front matter
PII S0749-3797(01)00382-8

Community 'How To' Guide to Underage Drinking Prevention,[4] developed in partnership with NHTSA as part of NAGHSR's Underage Drinking Prevention Program (UDPP).

But such resources are only part of the solution. Ensuring that effective measures are in place to prevent underage impaired driving is another key component. Those identified by the Task Force–maintaining minimum legal drinking age (MLDA) laws at 21 years of age and establishing a lower legal blood alcohol concentration (BAC) level for young and inexperienced drivers—are two important tools that can help local communities develop comprehensive strategies for dealing with the often tragic consequences when impaired underage drinkers get behind the wheel. Beyond the measures identified to prevent underage impaired driving, the other two impaired driving measures recommended by the Task Force—establishment of .08 BAC laws and use of sobriety checkpoints—also coincide with NAGHSR's perspective that legislation, where supported by strong evidence of effectiveness, is integral to improving highway safety, and that such measures must be coupled with educational and enforcement efforts such as checkpoints to be truly successful. State Highway Safety Offices continue to support zero tolerance and minimum drinking age laws, the enactment of .08 laws, and the enforcement of all these laws.

NAGHSR commends the work of the Task Force on these findings and contends that the measures recommended support the call for increased funding for state programs. There is no doubt that activities undertaken by the states, including enhanced enforcement of laws, education about technical assistance with safety measures such as child seats and seatbelts, and campaigns to prevent alcohol-impaired driving and underage drinking contributed to the lowest motor vehicle fatality rate on record in 1999. Additional behavioral research and increased implementation of those strategies recommended by the Task Force will help to further enhance the safety of motor vehicle occupants. NAGHSR looks forward to collaboration with NHTSA, CDC, and other federal and state agencies and organizations to accomplish this goal.

References

1. Zaza S, Sleet DA, Thompson RS, Sosin DM, Bolen JC, and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of child safety seats. Am J Prev Med 2001;21(suppl 4):31–47.
2. Dinh-Zarr TB, Sleet DA, Shults RA, et al., and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase the use of safety belts. Am J Prev Med 2001;21(suppl 4):48–65.
3. Shults RA, Elder RW, Sleet DA, et al., and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to reduce alcohol-impaired driving. Am J Prev Med 2001;21(suppl 4):66–88.
4. National Highway Traffic Safety Administration (NHTSA). Community 'how to' guide to underage drinking prevention (set of 9). Pub No DOT-HS-809-209. Washington, DC: NHTSA, March 2001.

Research As an Advocate's Toolkit to Reduce Motor Vehicle Occupant Deaths and Injuries

Millie Webb

I am honored to provide commentary on the *Guide to Community Preventive Services: Reducing Injuries to Motor Vehicle Occupants.* This *Community Guide* will undoubtedly supply thousands of traffic safety advocates with the necessary information to change policy and save lives in our nation.

The release of this information could not be more timely. The news from the traffic safety advocacy field should be cause for concern. Traffic safety advocates are grappling with a plateau in our efforts to reduce motor vehicle death and injury. Mothers Against Drunk Driving (MADD) was alarmed to see that more than 16,000 people were killed in alcohol-related traffic crashes in 2000—the first increase in 5 years (National Highway Traffic Safety Administration, Preliminary FARS estimates, 2001). This year marked the first year in recent memory when no state enacted a primary safety belt law.[1] Last May, we were horrified to discover that a majority of children killed in alcohol-related crashes were driven by a drinking driver.[2] Recent months have been consumed by a media debate over the wisdom of maintaining the 21 national minimum drinking age law—one of the most effective measures to reduce alcohol-related traffic crashes.[3]

After 2 decades of moving forward in the effort to reduce motor vehicle deaths and injuries, it appears that the nation may be poised to take a step back. Now more than ever, we must do all that we can to ensure that we move forward. It is of critical importance that we focus our energies around solutions that are proven effective.

Thirty years ago, my family was rear-ended by a drinking driver with a blood alcohol concentration (BAC) level of .08 percent. Upon impact, our car burst into flames. My family was catapulted onto the roadway. My daughter Lori and my nephew Mitchell died from the burns they sustained in the crash. My husband was badly burned in the crash. My neck was broken and 73% of my body was burned. I was pregnant at the time and our daughter, Kara, was born legally blind as a result of the injuries I sustained in the crash.

When our crash occurred, the laws and the public perception regarding drunk driving and traffic safety were not as they are today. It was commonplace that someone—without a second thought—might choose to drink and drive. And, as in the case of the man who was responsible for taking the lives of our daughter and nephew, an offender would be given a slap on the wrist for this crime.

In 1980, MADD was founded and I quickly joined. For the past 20 years both victims and nonvictims have worked together with one common goal—to stop drunk driving and to support the victims of this violent crime.

We are joined in the fight for safer roadways by thousands of other traffic safety activists working on many different issues such as child passenger safety and safety belt usage. Over the last 20 years more than 2300 laws have been passed to prevent impaired driving. Hundreds of laws have been passed to improve occupant protection and child passenger safety. As we strive to change the laws and then work to see that they are fully enforced, we rely heavily on scientific data to accomplish our goals.

In order to advocate effectively for lifesaving legislation, advocates must have clear and compelling scientific evidence to provide a basis for policy change. The combination of scientific research and advocacy efforts is key to success at the federal level, in state legislatures, and in communities across the nation. The marriage of science and advocacy has been very successful in advancing the nation's efforts to improve traffic safety.

Many of the laws that provide the greatest lifesaving benefits are quite controversial, and policymakers are all too often reluctant to embrace changes to existing statutes. Opponents of these proposed laws are often well funded and have many resources at hand to stall legislative efforts.

Traffic safety advocates depend on research to advance our cause and provide us with the credibility that we must establish with policymakers and the media in order to move past the arguments of our opponents.

We weave research findings into every piece of our advocacy efforts. We refer to research in media materials and interviews, statistics and policy position statements, lobbying materials, Internet sites, information briefings, and our public statements.

Community guides like this one are the advocate's

From Mothers Against Drunk Driving (MADD), Dallas, Texas

Address correspondence to: Brandy Anderson, Director of Public Policy, MADD National Office, 511 E. John Carpenter Freeway #700, Irving, TX 75062. E-mail: Brandyand@aol.com.

 PII S0749-3797(01)00385-3

toolbox. This *Community Guide* provides a blueprint for advocates to follow in order to galvanize necessary policy change. It recommends a menu of policies for use in communities that choose to place priority on the laws and programs most likely to save lives and prevent injuries. It provides clear and concise information on research findings, effectiveness, applicability, positive and negative effects, cost benefit, and possible barriers to the implementation of each recommended solution.

Typically, advocates for policy change are not trained researchers. Many times we are just volunteer mothers and fathers, sons and daughters, and concerned citizens who want to save lives and keep families together. For people like me who spend their days working to change public perception and pass effective laws and policies, this *Community Guide* is a map that leads us to the policy changes that will work most effectively and will enable us to reach our goals of reducing the number of motor vehicle deaths and injuries.

MADD is part of the Partners In Progress effort spearheaded by the Department of Transportation.[4] Our goal is to reduce alcohol-impaired driving deaths to no more than 11,000 yearly by 2005. Clearly, we have a lot of work to do if we are to meet that goal in just 3 more years. We must put our efforts behind the recommendations outlined in this report. This *Community Guide* will be one of the most useful resources for any person working to improve traffic safety and public health.

Next year, the United States Congress will begin to focus on the 2003 reauthorization of the Transportation Efficiency Act of the 21st Century (TEA-21). Traffic safety advocates will be striving to ensure that traffic safety is a priority in this massive multi-billion dollar legislative package that will pave the roadways for the new millennium.

Traffic safety advocates will be working to maintain existing safety provisions, add new safety measures, and allocate more resources for traffic safety enforcement and research as well as prevention efforts. As we enter into this Congressional debate, the *Community Guide* can serve as the scientific justification for many improvements to our nation's highway funding legislation.

We have come so far in the last 20 years, but we have a long way to go in the fight to save lives and prevent injuries caused by motor vehicle crashes on America's roads. Complacency is our greatest enemy. We must refocus the nation on the issue of traffic safety and its importance to public health. Scientific research will provide that focus for us and will light the path for us to follow as we advocate for safer roads.

References

1. Air Bag Seat Belt Safety Campaign, 2001.
2. Quinlan, KP, Brewer RD, Sleet DA, Dellinger AM. Characteristics of child passenger deaths and injuries involving drinking drivers. JAMA 2000;17: 2249–52.
3. Shults RA, Elder RW, Sleet DA, et al. and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to reduce alcohol-impaired driving. Am J Prev Med 2001;21(suppl 4):66–88.
4. U.S. Department of Transportation. Partners in Progress. National Highway Traffic Safety Administration. Washington, DC, 1995.

The Effectiveness Review Trials of Hercules and Some Economic Estimates for the Stables

Ted R. Miller, PhD, MS

The literature on motor vehicle safety is vast. Consequently the review effort reported in this supplement was Herculean in scope and difficulty. It introduced me to many solid and important effectiveness studies. At the same time, it occasionally omitted effectiveness studies that I cite. Returning to my sources heightened my appreciation of the Task Force on Community Preventive Service's (the Task Force) trials. The first trial was finding the studies. Two examples are informative. A National Center for Health Statistics publication[1] finds that 92% of low-income parents who own child safety seats use them routinely. That report, however, covers a wide range of parental safety practices. It lacks keywords and is not indexed. Again, an article in an economics journal[2] uses confidential 1983 National Personal Transportation Survey microdata to analyze how people make decisions about using motor vehicle safety equipment. The paper includes a logit regression explaining child seat use. One explanator is residence in a state with a child safety seat use law (in force in 1983 in 15 states housing 38.5% of the 934 respondents with children under age 5). The model focuses on the influence of individual factors like parent age, income, and education on seat use decisions, but in the process it produces the best extant evaluation of the impact those laws had on seat use. It finds that laws increased seatbelt use by 42.3%, with 17.7% diverted from belts and 24.6% restrained for the first time. These findings, however, are by-products. They do not appear in the abstract and merit only one sentence in the text. To the author, a restraint law was just another regression coefficient. How could a systematic search find these studies?

The Task Force's second trial was evaluations measuring different outcomes of comparable interventions. Despite many sound evaluations, the number using any single measure sometimes was dangerously small. Seemingly anomalous meta-analytic effectiveness estimates sometimes resulted. Most notably, when most child seat laws passed, child seat effectiveness was about 54% against fatalities and 52.5% against nonfatal injuries.[3] So child seat laws should decrease deaths and injuries proportionally and by roughly half the amount that use increases. Yet, in the studies reviewed in Table 2 of Zaza et al.,[4] laws decrease deaths and injuries combined by 17.3% but decrease deaths alone by 35% and increase use by just 13% (24% if we add the Blomquist study[2]). By dividing deaths and injuries by effectiveness, we can convert the estimates to compatible units. Doing so reveals that one study, which found 57.3% effectiveness against fatalities, must have been analyzing effectiveness among seat users (or else laws brought 100% seat use). Across the remaining studies including Blomquist, it appears that use increased by 35% at the median, reducing deaths and injuries by 18%.

The third trial, which the Task Force handled extremely well, was co-mingled interventions. States do not legislate for the convenience of evaluators. Especially when attacking impaired driving, they often simultaneously implement a package of interventions. The Task Force had to reject some otherwise sound evaluations because studies either could not separate the effects of packaged changes or attributed improved outcomes to a subset of the actual package. It is unclear if we even should try to separate impacts of package components. Synergy may heighten their yield.

The fourth trial was meritorious effectiveness estimates that could not be converted to the Task Force's chosen effectiveness units using only information in the articles. The necessary information occasionally was available from other publications or by contacting the authors. I wish the Task Force had been able to salvage those estimates. Well-designed studies are rare enough that we need every one.

The fifth trial was time-dependent effectiveness. The effectiveness estimates for child safety seat community information/enforcement and education/use incentives come from years when most parents did not use child seats. Today, people know that child seats are a part of good parenting. It seems unlikely that these measures would have nearly as much impact now that both national observation surveys and parent interviews suggest that use exceeds 90%. Similarly, it would be useful to assess the impacts of enforcing safety belt laws as a function of pre-enforcement usage rates.

The sixth trial was inaccurate police reporting. Police

From the Pacific Institute for Research and Evaluation, Calverton, Maryland

Address correspondence to: Ted R. Miller, PhD, MS, Pacific Institute for Research and Evaluation, 11710 Beltsville Drive, #300, Calverton, MD 20705. E-mail: miller@pire.org.

 PII S0749-3797(01)00383-X

reports code 26% of the injured as uninjured, but 12% of people coded as injured are not.[5] These errors vary considerably among states and sometimes are predictable consequences of definitional differences.[6,7] Thus, state-specific estimates of the impact on police-reported injuries, especially serious injuries, may differ because of definitions. Meta-analysis averages these inherently inconsistent estimates. Again, comparisons with blood alcohol measurements by medical personnel show that police do not code alcohol involvement in 26.9% of injury crashes with driver blood alcohol concentration (BAC) above 0.10, and 54.6% with lower positive BACs.[8] Adjusting the estimates in Table 2 of the article by Shults et al.[9] accordingly with data on miles driven by BAC[10] yields estimated probabilities of 67% in late-night, single-vehicle, nonfatal-injury crashes and 60% in all late-night nonfatal-injury crashes. Those percentages are virtually identical to the 64% and 60% in fatal crashes. They cast a different light on the proxy measure assessment done by Shults et al.[9]

The final trial was the troubling dearth of economic analyses. The important question is why so few exist. These analyses could be done in two ways—as part of an intervention evaluation or by applying effectiveness data and separately modeled data on the injury costs that can be avoided. Because of the expense of collecting cost-savings data, the latter approach is preferable. The necessary injury cost data have been published.[11] So why not cost-outcome analyses? Because no intervention cost data exist! Published program descriptions and effectiveness evaluations almost never report costs of program implementation or replication. To learn the cost-effectiveness of programs, we need to change that. Peer reviewers and journal editors need to push for cost data, perhaps even by making program cost a category in structured abstracts describing interventions.

Economic Analysis

The rest of my comments add economic analysis data, review problem size, and estimate benefit–cost ratios and costs per quality-adjusted life year (QALY) saved for the interventions. This is based on the methods in my review of 84 cost-outcome analyses in injury prevention and control,[12] presenting estimates in 1997 dollars for comparison to that review's estimates, and sometimes refining its estimates.

Table 1, drawn from a recent article,[11] summarizes the cost impacts of the problems examined by the Task Force. Alcohol-impaired driving is the largest problem, followed closely by unbelted driving. These problems dwarf those of impaired driving by underage drinkers and especially child seat non-use. The analyses use these data and unit costs from the same article to value benefits. They also use the child seat benefit-cost information in an article[13] that evaluated a more generic child seat intervention than the ones the Task Force analyzed. The analyses examine societal savings. The measures evaluated are described in the Task Force reviews.

Table 1. Costs of problem behaviors in 1993 (in millions of 1997 dollars)

	Impaired driving	Impaired driver under age 21	Child seat non-use	Belt non-use
Medical	5,161	1,206	89	4,136
Other monetary	35,568	7,312	488	29,117
Quality of life	59,752	13,777	1,561	61,686
Total	100,481	22,295	2,138	94,939

Source: Miller et al.,[11] inflated to 1997 dollars.

How can we estimate intervention costs, given that none were published? For laws and regulations, we can use Downing's[14] estimates that the costs of approving mandates average 2.9% to 7.1% of the first-year direct costs imposed on the public, with public implementation and administration costing another 4.2% to 4.6%. This means that total costs will average 9.4% more than first-year direct costs.

A child seat law increases seat use (and presumably seat purchase) at a retail price around $45 per seat. Thus, per seat purchased, a child seat law costs $49 ($45 × 1.094). Telephoning staff at the National SAFE KIDS Campaign and a few active local program operators suggests that child seat distribution programs distribute seats at $45 or less. This estimate includes the cost of counseling on correct use. The benefits analysis[13] accounts for non-use by seat owners.

Forced belt use imposes temporary discomfort and inconvenience costs estimated at $22 per new user per month.[15] I assume that these costs persist for 6 months, then fall to 10% of their prior level as people get used to buckling up. Costs and return on belt laws are evaluated over the first 5 years post-implementation, with Downing's factors applied to first-year costs. Since the costs and benefits of belt law passage both are linear functions of the number of new belt users, passing a seat belt law and changing a secondary law to primary have the same benefit–cost ratio. Belt law enforcement adds travel delay costs to the discomfort costs. Usage checkpoints typically delay vehicles for 5 minutes. With 17% short-term effectiveness and 14% long-term,[16] North Carolina's checkpoints per registered vehicle, the U.S. average of 1.5 occupants per vehicle, and delay time per occupant valued at 50% of the wage rate,[17] delay costs add $0.83 to the cost per new belt user. The Downing factors suggest that an intensive belt-use enforcement program would cost $485 to $800 million to implement nationwide, with the lower end of the range more probable since only administrative action is required. Confirming this estimate, costs would be $570 million with police costs per belt use checkpoint equal

Table 2. Benefit–cost ratios and costs/QALY for selected highway safety measures (in 1997 dollars)

		Benefits (costs averted)					
	Unit cost	Medical	Other monetary[a]	Quality of life	Total benefits[b]	Cost ratio	Benefit–cost/QALY[c]
Child safety seat law	$49/seat purchased	$100	$360	$1,000	$1,500	31	<$0
Child safety seat distribution	$45/seat distributed	$100	$360	$1,000	$1,500	34	<$0
Pass a belt law	$260/new user	$180	$1,260	$2,670	$4,110	16	<$0
Upgrade secondary law to primary	$260/new user	$180	$1,260	$2,670	$4,110	16	<$0
Enhanced belt law enforcement	$240/new user	$150	$1,030	$2,170	$3,350	14	<$0
.08% driver blood alcohol limit	$2.70/driver	$2	$13	$22	$38	14	<$0
0-tolerance of alcohol, drivers under 21	$29/driver	$38	$210	$400	$650	22	<$0
21 minimum legal drinking age	$150/youth 18–20	$27	$160	$300	$490	3.2	$18,000
Sobriety checkpoints	$8200/checkpoint	$3,400	$15,100	$37,000	$55,500	6.8	<$0
Mandatory server training	$59/driver	$10	$71	$120	$200	3.4	$16,000

[a]Monetary costs include direct nonmedical cost savings as well as indirect work loss savings. Cost/QALY = QALYs saved/(intervention cost-direct cost savings)

[b]Numbers do not correspond exactly to prior columns due to rounding. All numbers were computed, then rounded.

[c]Cost/QALY, <$0 means the intervention offers net cost savings.

Note: These estimates can be compared to the 84 estimates in Miller and Levy[12] but supercede those estimates for belt laws and .08 blood alcohol limits. The 0-tolerance and sobriety checkpoint estimates come from the Task Force review.

to the costs per sobriety checkpoint net of breath testing equipment costs (about $6900)[18] and North Carolina publicity costs for belt use checkpoints of $0.5 million (F Smith, North Carolina Department of Transportation, personal communication, 1997) used as the average cost per state.

Assume that a .08 BAC law would cause impaired drivers to reduce the trips they would have taken with BACs of .08 and over by 6.5%, the same percentage as the decline in alcohol-related fatalities that resulted from these laws (the average of the two multi-state evaluations that separated the effects of administrative license revocation[9]). With miles driven by BAC in 1991[10] and the cost per mile of mobility loss,[12] costs of .08 are $2.70 per licensed driver (1.094 × .065 × 20,819 million miles × $.31 × 1.094/171.5 million drivers).

Similarly, assume that the 21 minimum legal drinking age (MLDA) reduced alcohol consumption among 18- to 20-year-olds by the same 19% as alcohol-related crashes.[9] Combining this information with National Household Survey on Drug Abuse data and alcohol sales data[19] suggests that sales declined by $1.48 billion (6.7% of consumption by youth aged 18 to 20 in 1996–1998 × $94 billion in alcohol sales × 0.19/0.81), so MLDA cost $150 per youth (1.094 × 1.48 billion/10.6 million youth).

Again, assume that mandatory server training decreased drinking over the legal limit while away from home by the same 23% that the Task Force reports it decreased alcohol-related crashes in Oregon. To compute the direct costs of server training, we multiply annual alcohol sales times the 40% of alcohol consumed by people who are over the legal limit times an assumed 75% of excess consumption that occurs outside the home times the 34.5% reduction times 1.094, arriving at a cost of $59 per driver. If implemented nationwide, Downing's estimate is that implementation and administration would cost $410-$450 million. Estimated directly in sensitivity analysis, with roughly 1.5 to 2 million alcohol servers nationwide, implementation cost would be a slightly lower $250 to $330 million.

Space does not permit deriving the benefits of each intervention, which came from the problem costs and the Task Force's effectiveness estimates. The computations tend to be straightforward. To give one example, the Task Force estimates that upgrading to a primary belt law reduces unbelted occupants by 14.1 percentage points from the 40% non-use level for 1993 in Table 1. Nationwide, upgrading would have saved $33.5 billion annually (94 × 14.1/40).

Sensitivity analysis revealed a curious fact. Unit purchase, alcohol sales reductions, and discomfort costs dominate the costs of these measures, with the remaining costs computed from them. Consequently, provided the items purchased or used are effective, the benefit–cost ratios and cost/QALY saved for child seat laws and giveaways, belt laws, .08 BAC laws, 21 MLDA, and mandatory server training are completely insensitive to their percentage effectiveness at changing usage, although net savings change linearly with usage. Applying this costing approach to laws mandating zero alcohol tolerance for drivers under age 21 would not make sense, however, because the alcohol is being sold illegally. The literature on crime suggests that criminals should not be considered to suffer losses—in this case lost sales—when their ill-gotten gains are cut off.[20] The same observation holds for the benefit–cost ratio for enforcing laws against serving intoxicated patrons,[12] a frequent companion to server-training programs. The difference in treatment of reduced alcohol consumption somewhat artificially makes law enforcement seem like a better investment than server training.

Table 2 shows the results. All the interventions yield large returns on investment, given that discomfort and

inconvenience costs and reduced alcohol sales are included in the intervention costs. Even the measures with costs/QALY of $16,000 to $18,000 are attractive investments when judged by the criteria suggested in my review of 84 safety measures.[12] That is especially true since the 21 MLDA and server-training estimates are quite conservative. They exclude reductions in barroom brawls, vandalism, high-risk sex, and other adverse consequences of public drinking to excess.

Thus, economic analysis reaffirms the Task Force recommendations to adopt and maintain these interventions.

This commentary was supported in part by NIAAA grant 5 R01-AA12208-03 and NHTSA contract DTNH22-98-D-35079, Task Order 7. All content is solely the author's.

References

1. Mayer M, LeClere FB. Injury prevention measures in households with children in the United States, 1990. Advance Data 250. Hyattsville, MD: National Center for Health Statistics, 1994.
2. Blomquist G. Motorist use of safety equipment: expected benefits of risk incompetence? J Risk Uncertainty 1991;4:135–52.
3. Partyka S. Lives saved by child safety seats from 1982 through 1987, Report 89-1A-O-002. 12th International Technical Conference on Experimental Safety Vehicles, 1989.
4. Zaza S, Sleet DA, Thompson RS, Sosin DM, Bolen JC, and The Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of child safety seats. Am J Prev Med 2001;21(suppl 4):31–47.
5. Miller TR, Viner JG, Rossman SB, et al. The costs of highway crashes, Washington DC: The Urban Institute; 1991.
6. O'Day J, ed. Accident data quality: A synthesis of highway practice. National Cooperative Highway Research Program Synthesis 192, Transportation Research Board, National Research Council, Washington DC: National Academy Press, 1993.
7. Viner JG, Conley C. Consistency of police reported "incapacitating injuries" between states. Working Paper. Federal Highway Administration, 1994.
8. Miller TR, Blincoe LJ. Incidence and cost of alcohol-involved crashes in the United States. Accid Anal Prev 1994;26:583–92.
9. Shults RA, Elder RW, Sleet DA, et al., and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to reduce alcohol-impaired driving. Am J Prev Med 2001:21(suppl 4):66–88.
10. Miller TR, Lestina DC, Spicer RS, Levy DT. How intoxicated are drivers in the United States: estimating the extent, risks, and costs per kilometer of driving by blood alcohol level. Accident Analysis Prev 1999;31:515–23.
11. Miller TR, Lestina DC, Spicer RS. Highway crash costs in the United States by driver age, blood, alcohol level, victim age, and restraint use. Accident Analysis Prev1998;30;137–50.
12. Miller TR, Levy DT. Cost-Outcome Analysis in Injury Prevention and Control: 84 Estimates for the United States. Medical Care 2000;38:562–82.
13. Miller TR, Demes JC, Bovbjerg RR. Child seats: How large are the benefits and who should pay? Paper 933089, Child Occupant Protection. Warrendale, PA: Society of Automotive Engineers, 1993:81–90.
14. Downing PB. Policy consequences of indirect regulatory costs. Public Policy 1981;29:507–26.
15. Blomquist G. Value of life saving: implications of consumption activity, J Political Economy 1979;87:540–58.
16. Dinh-Zarr TB, Sleet DA, Shults RA, et al., and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase the use of safety belts. Am J Prev Med 2001;21(suppl 4):48–65.
17. Office of the Secretary. Departmental guidance for the valuation of travel time in economic analysis. Washington DC: U.S. Department of Transportation, 1997.
18. Miller TR, Galbraith MS, Lawrence BA. Costs and benefits of a community sobriety checkpoint program, J Studies Alcohol 1998;59:462–68.
19. Bureau of the Census. Statistical Abstract of the United States 1997. Washington DC: U.S. Goverment Printing Office, 1997.
20. Trumbull WN. Who has standing in cost-benefit analysis? J Policy Analysis Management 1990;9:201–18.

The *Guide to Community Preventive Services*
A Public Health Imperative

Lloyd F. Novick, MD, MPH, Alex Kelter, MD

The *Guide to Community Preventive Services* (the *Community Guide*) promises to be a substantial and necessary tool in collective efforts to improve the public health. This supplement to the *American Journal of Preventive Medicine* (*AJPM*) is important, not only for its content, but for the example provided of this approach in practice and policymaking. Painstaking and meticulous methodology yielded extensive reviews of evidence relevant to the reduction of injuries to motor vehicle occupants by increasing child safety seat use, increasing safety belt use, and reducing alcohol-impaired driving. The evidence is then weighed, with a specified protocol, to determine if recommendations can be formulated.[1–3] Akin to the *Guide to Clinical Preventive Services*, initially issued in 1989 by the U.S. Preventive Services Task Force and aimed at prevention for the individual patient, this new guide steers an evidence-based course through the broader ocean of population-based prevention.[4,5] Although great progress has been made, as this supplement demonstrates, the future holds significant challenges for this undertaking.

In 1993, The Council on Linkages Between Academia and Public Health Practice (the Council on Linkages) (see Endnote) debated their potential involvement in developing public health practice guidelines. Enthusiasm was tempered with doubts about the effectiveness and feasibility of this initiative.[6] In addition to the issue of turf (who would promulgate the guidelines), two major questions were: (1) availability of evidence on public health interventions to support recommendations, and (2) feasibility of implementation of evidence-based recommendations dependent on acceptability to practitioners in diverse roles and geographic settings. Eight years later, major efforts of the Task Force on Community Preventive Services (the Task Force) are tackling similar areas, critical to the eventual success of the undertaking.

Support provided by the W. K. Kellogg Foundation enabled a 2-year effort by the Council on Linkages to answer the above questions. Four public health issues were chosen for study: (1) immunization of preschool children, (2) completion of treatment for tuberculosis, (3) prevention of cardiovascular disease, and (4) lead poisoning. Relevant literature was identified through searches of electronic databases, inquiries were made of experts on each topic, and queries for information were made to selected state departments of health. At a conference in Baltimore in April 1995, the expert panels concluded that: (1) public health practice guidelines are feasible, based on scientific evidence and other empirical information; and (2) the potential benefits of public health practice guidelines are immediate and far-reaching.[7] The Council on Linkages reported these findings at meetings of the Public Health Functions Group of the U.S. Public Health Service (USPHS) attended by Philip R. Lee, then Assistant Secretary for the U.S. Department of Health and Human Services; David Satcher, then Director of the Centers for Disease Control and Prevention (CDC); and representatives of the other USPHS agencies. In 1996, CDC, at the request of the USPHS, convened a 15-member independent and nonfederal Task Force on Community Preventive Services.[5]

With 5 years of activity, the Task Force and staff have made Herculean efforts to accomplish its mission. As stated by Stephanie Zaza, Chief of the Community Guide Branch, the purpose is to "improve public health practice by increasing the use of effective interventions and decreasing the use of ineffective interventions."[8] Fifteen topic areas were grouped by three categories: (1) changing risk behaviors; (2) addressing specific diseases, injuries, and conditions (including motor vehicle occupant injuries); and (3) addressing environmental and ecosystem challenges.

The potential of the *Community Guide* has already been demonstrated by the contributions on vaccine-preventable disease, tobacco use prevention and cessation, and now on prevention of injury to motor vehicle occupants with evidence-based reviews and recommendations published in the CDC *Morbidity and Mortality Weekly Reports* (MMWR).[9–11] Recommendations on vaccine-preventable disease were incorporated into other documents important to immunization policy including the Institute of Medicine Report, *Calling the Shots: Immunization Finance Policies and Practice.*[12]

The fields of immunization and the prevention of smoking and motor vehicle injury may be more amenable to evidence-based recommendations because of

From the Onondaga County Health Department (Novick), Syracuse, New York; and the Epidemiology and Prevention for Injury Control Branch, California Department of Health Services (Kelter), Sacramento, California

Address correspondence and reprint requests to: Lloyd F. Novick, MD, MPH, Commissioner, Onondaga County Health Department, 421 Montgomery Street, Syracuse, NY 13202. E-mail: hllnovi@health.ongov.net.

 PII S0749-3797(01)00384-1

the availability of evaluative studies meeting the rigorous criteria. Insufficient evidence for interventions is a challenge faced by the Task Force. While the recommendation protocol allows for expert opinion, this option has not been used to keep guidance squarely evidence-based.[2] A potential peril is the misinterpretation by practitioners, legislators, and others that recommendations not made because of insufficient evidence are recommendations against the intervention. An associated and valuable by-product of findings of insufficient evidence is the identification of numerous public health issues requiring research.

All of the above applies to the evidence reviews and recommendations published in this supplement. Evidence for the effectiveness of strategies was identified for the great majority of interventions on reducing injuries to motor vehicle occupants. Questions for future research were also identified, including the applicability of these programs in different settings and populations. Similar to other topics investigated by the Task Force, there was little or no economic information available for many of these strategies. Sufficient evidence was available to support recommendations in the areas of child safety seat use, seat belt use, and reduction of alcohol-impaired driving.[13–16] Findings such as the strong evidence that primary safety belt laws are more effective than secondary (enforcement only in association with another offense) will aid public health policy determinations and practice.[14] A key finding of strong evidence for the effectiveness of state legislation setting .08% blood alcohol concentration (BAC) limit for driving has already made policy inroads on federal and state levels.[15]

Marguerite Pappaioanou, former Chief of Community Preventive Services Guide Development, and Caswell Evans Jr., Chairperson of the Task Force, identified the primary target audience of the *Community Guide* as "rich and diverse" composed of those "involved in the planning, funding, and implementation of population-based services and policies to improve the health at the community and state levels."[5] Field-testing of chapters and early feedback and input from the readership are seen as a priority. A primary objective of dissemination is encouraging various units within CDC and other federal agencies, such as the National Cancer Institute (NCI) and the National Highway Traffic Safety Administration (NHTSA), to implement the *Community Guide* findings among their partners and networks. (B Myers, Community Guide Branch, CDC, personal communication, 2001.)

Recommendations are to be implemented in partnerships with public health departments, managed care organizations, and employer groups.[8] Three local partnerships have been established in Detroit, Denver, and Connecticut to pilot the *Community Guide* recommendations. (B Myers, Community Guide Branch, CDC, personal communication, 2001.) Plans to improve *Community Guide* dissemination are frequently discussed at meetings of the Task Force. At the June 2001 meeting, Deborah Porterfield, North Carolina Division of Health, reported a low level of awareness among colleagues and others in the *Community Guide* target audience at a series of presentations.[17] Increased recognition of this valuable resource needs to occur for practitioners, health maintenance organizations, and policymakers. The Association of State and Territorial Health Officials (ASTHO) and the National Association of City and County Health Officials (NACCHO) can play a more active role here. Incorporation into the curricula at schools of public health and residency training programs in preventive medicine also are steps in the right direction.

The earlier *Guide to Clinical Preventive Services* has achieved a high level of awareness among practitioners, employers, and policymakers with an interest in prevention interventions directed at the individual. The *Guide to Community Preventive Services* has published chapters on vaccine-preventable disease, tobacco, prevention of motor vehicle injury (in this supplement to *AJPM*) and will publish seven additional chapters to be included in the first volume of the *Guide to Community Preventive Services* in late 2003. The Task Force is planning to add at least two chapters a year and update published chapters in the future. The breadth of the *Community Guide* and the large investment in required resources have been important issues dating to the inception of the Task Force. How is the scope of population-based prevention, with the broad array of socioenvironmental health determinants, best addressed, particularly with a rigorous and demanding methodology requiring at least 2 years to produce a chapter? A recent decision to outsource evidence reviews is a sound measure to expedite this process.

From the outset, CDC has shouldered the major responsibility for staff and for providing evidence reviews for the Task Force. As conceived, the overall effort for public health guidelines was to be assumed by the USPHS. Although some important assistance in the last 5 years has been forthcoming from these other agencies, it is increasingly clear that the magnitude and vital nature of this undertaking demands increased involvement and investment by other USPHS entities including the National Institutes of Health. The *Community Guide* must continue to move forward, for its success is vital to all of our collective efforts to improve public health.

Beyond the work of the Task Force itself lie several critical issues that must be faced before the *Community Guide* can claim its share of the success of prevention. First is the issue of social commitment. As has been the case for many years for lead poisoning prevention in children, enough is known about how to improve vehicle occupant safety and reduce the vehicle occupant death toll substantially across the United States

without further delay. What is lacking is the political will to bring to scale the myriad of "demonstration projects" and small, competitive awards that are scattered nonsystematically in health departments and traffic safety programs around the country. Perhaps one of the difficulties with eliciting this political will lies in the second issue—economics. Few question the moral and social value of saving lives, but our ability to translate these moral and social values to economic values needs more attention. From which agencies will funds be sought to support nationwide prevention efforts? Are these the agencies that will reap the savings when injuries are prevented? If not, how will they justify the expenditures? Can public health leaders help create a coalition of insurance carriers, medical care provider organizations, government payers, auto manufacturers, and others that would be willing to pay for the prevention efforts up front?

Third is the issue of public health infrastructure. There are few injury prevention interventions ready to be implemented nationwide. Several of those that are available now are described in this supplement to *AJPM*. But how many health departments are ready now to accept funds; create or strengthen their partnerships with law enforcement, traffic safety, alcohol prevention, and medical care agencies; and launch new initiatives to reduce vehicle-related injuries? Again, sadly, the answer is "precious few."

A final point is the broader issue of the context in which people use vehicles in the first place. Perhaps this is an issue of "exposure" to the "vector." Certainly, motor vehicles are destined to be the way most Americans move from place to place for years to come, making the prevention interventions described in this supplement vital now. But who thought 50 years ago that Americans would feel the way they do today about smoking? Not many. Public health and transportation leaders must be in the forefront of the changes that will take place to reduce people's risk of injuries from automobile crashes by reducing automobile trips as a percentage of total person-trips in communities all over the country. With the high proportion of serious injuries, disabilities, and deaths that occur from vehicle-related injuries within so few miles of home, we would all be safer and healthier in so many ways if we could walk to school, the supermarket, the tavern, and the movie theatre, or at least not have to drive a car there.

Efforts like those of the Task Force will go a long way toward achieving our prevention goals by making it possible to be selective about the priorities we establish, the partnerships we build, and the methods we choose as we shepherd scarce resources to make prevention a priority.

Endnote:

In 1993, the Council on Linkages was composed of representatives of the Association of State and Territorial Health Officials (ASTHO), the National Association of County Health Officials (NACCHO), American Public Health Association (APHA), Association of Schools of Public Health (ASPH), American College of Preventive Medicine (ACPM), Centers for Disease Control and Prevention (CDC), and the Health Resources Services Administration (HRSA). One of the authors (LN) was Chair of the Council (1993-1996) and has been a consultant to the Task Force since 1996.

References

1. Truman BI, Smith-Akin CK, Hinman AR, et al., and the Task Force on Community Preventive Services. Developing the Guide to Community Preventive Services: an overview and rationale. Am J Prev Med 2000; 18(suppl 1):18–26.
2. Briss PA, Zaza S, Pappaioanou M, et al., and the Task Force on Community Preventive Services. Developing an evidence-based Guide to Community Preventive Services. Am J Prev Med 2000;18(suppl 1):35–43.
3. Zaza S, Carande-KulisVG, Sleet DA, et al., and the Task Force on Community Preventive Services. Methods for conducting systematic reviews of the evidence of effectiveness and economic efficiency of interventions to reduce injuries to motor vehicle occupants. Am J Prev Med 2001;21(suppl 4):23–30.
4. U.S. Preventive Services Task Force. Guide to Clinical Preventive Services: an assessment of the effectiveness of 169 interventions. Baltimore, MD: Williams & Wilkins, 1989.
5. Pappaioanou M, Evans C Jr. Development of the Guide to Community Preventive Services: a U.S. Public Health Service initiative. J Public Health Manage Pract 1998;4:2:48–53.
6. Novick LF. Public Health Practice Guidelines: a case study. J Public Health Manage Pract 1997; 3:1:59–64.
7. Council on Linkages Between Public Health Practice and Academia. Practice guidelines for public health: assessment of scientific evidence, feasibility and benefits. A report of the Guideline Development Project for Public Health Practice. Baltimore, MD: Council on Linkages Between Public Health Practice and Academia, 1995:1–60.
8. Zaza S, Pickett JD. The Guide to Community Preventive Services: update on development and dissemination activities. J Public Health Manage Pract 2001;7:1:92–4.
9. Centers for Disease Control and Prevention. Vaccine-preventable diseases improving vaccination coverage in children, adolescents and adults. a report on recommendations of the Task Force on Community Preventive Services. MMWR 1999;48(RR-8):1–15.
10. Centers for Disease Control and Prevention. Strategies for reducing exposure to environmental tobacco smoke, increasing tobacco-use cessation and reducing initiation in communities and health care systems: a report on recommendations of the Task Force on Community Preventive Services. MMWR 2000;49(RR-12):1–11.
11. Centers for Disease Control and Prevention. Motor-vehicle occupant injury: strategies for increasing use of child safety seats, increasing use of safety belts, and reducing alcohol-impaired driving. A report on recommendations of the Task Force on Community Preventive Services. MMWR 2001;50(RR-7):1–13.
12. Committee on Immunization Finance Policies and Practices, Division of Health Care Services and Division of Health Promotion and Disease Prevention, Institute of Medicine. Calling the shots: immunization finance policies and practices. Washington, DC: National Academy Press, 2000.
13. Zaza S, Sleet DA, Thompson RS, Sosin DM, Bolen JC, and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of child safety seats. Am J Prev Med 2001;21(suppl 4):31–47.
14. Dinh-Zarr TB, Sleet DA, Shults RA, et al., and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase the use of safety belts. Am J Prev Med 2001;21(suppl 4):48–65.
15. Shults RA, Elder RW, Sleet DA, et al., and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to reduce alcohol-impaired driving. Am J Prev Med 2001:21(suppl 4):66–88.
16. Task Force on Community Preventive Services. Recommendations to reduce injuries to motor vehicle occupants: increasing child safety seat use, increasing safety belt use, and reducing alcohol-impaired driving. Am J Prev Med 2001:21(suppl 4):16–22.
17. Porterfield, D. Dissemination of Task Force work in North Carolina. Quarterly Meeting of the Task Force on Community Preventive Services, June 13–14, 2001, Decatur, Georgia.

Recommendations to Reduce Injuries to Motor Vehicle Occupants

Increasing Child Safety Seat Use, Increasing Safety Belt Use, and Reducing Alcohol-Impaired Driving

Task Force on Community Preventive Services

Medical Subject Headings (MeSH): accidents, traffic; alcohol drinking; motor vehicles; wounds and injuries; infant equipment; protective devices; seat belts; community health services; decision making; evidence-based medicine; economics; preventive health services; public health practice (Am J Prev Med 2001;21(4S):16–22)

Introduction

Motor vehicle–related injuries kill more children and young adults than any other single cause in the United States,[1,2] and they are the leading cause of death from unintentional injury for persons of all ages.[3,4] More than 41,000 people in the United States die in motor vehicle crashes each year,[5] and another 3.5 million people sustain nonfatal injuries.[1] Moreover, crash injuries result in about 500,000 hospitalizations and 4 million emergency department visits annually.[6]

When crash injuries and deaths are viewed from a purely economic perspective, the burden to society is tremendous. Motor vehicle–related deaths and injuries cost the United States more than $150 billion annually,[7,8] including $52.1 billion in property damage, $42.4 billion in lost productivity, and $17 billion in medical expenses.[7] Alcohol-related crashes contribute substantially to these costs, with a direct economic impact of about $45 billion in 1994 alone.[7]

Motor vehicle injury reduction remains a formidable public health challenge, despite the impressive declines in motor vehicle–related death rates achieved since 1925.[9] Child safety seats, safety belts, and deterrence of alcohol-impaired driving are among the most important preventive measures to further reduce motor vehicle occupant injuries and deaths.[10,11]

The recommendations in this report represent the work of the independent, nonfederal Task Force on Community Preventive Services (the Task Force). The Task Force is developing the *Guide to Community Preventive Services* (the *Community Guide*) with the support of the U.S. Department of Health and Human Services (DHHS) in collaboration with public and private partners. The Centers for Disease Control and Prevention (CDC) provides staff support to the Task Force for development of the *Community Guide.*

This report provides recommendations on interventions to increase use of child safety seats, to increase use of safety belts, and to reduce alcohol-impaired driving. These areas were chosen because (1) use of child safety seats and use of safety belts are below national goals[12]; (2) 38% of traffic deaths involve alcohol[5]; and (3) not using child safety seats, not using safety belts, and alcohol-impaired driving are among the most important contributors to motor vehicle occupant injuries; reducing these three risk behaviors could dramatically reduce these injuries. These recommendations present evidence-based options appropriate for community, state, and national programs.

The Task Force recommendations are based primarily on the effectiveness of the intervention as determined by the systematic literature review process (described in the accompanying review articles).[13–15] In making its recommendations, the Task Force balances the information about effectiveness with information about other potential benefits and the potential harms of the intervention itself. The Task Force also considers the applicability of the intervention to various settings and populations in determining the scope of the intervention. Finally, the Task Force reviews economic analyses about effective interventions. Economic information is provided to assist the reader with decision making, but does not affect the Task Force's recommendation.

The specific methods for and results of the reviews of evidence on which these recommendations are based are provided in the accompanying articles.[13–16] General methods employed in evidence reviews for the *Community Guide* have been published previously.[17]

These recommended interventions can be used to

The names and affiliations of the Task Force members are listed on page v of this supplement, and at www.thecommunityguide.org.

Address correspondence and reprint requests to: Stephanie Zaza, MD, MPH, Chief, Community Guide Branch, Centers for Disease Control and Prevention, 4770 Buford Highway, MS-K73, Atlanta, GA 30341. E-mail: szaza@cdc.gov.

0749-3797/01/$–see front matter
PII S0749-3797(01)00380-4

Table 1. Selected *Healthy People 2010*[12] objectives and National Highway Traffic Safety Administration (NHTSA) goals related to motor vehicle occupant injury

Healthy People 2010 objective	NHTSA goal
General	
Reduce deaths caused by motor vehicle crashes from 15.0 per 100,000 persons (1998 preliminary data, age adjusted to the year 2000 standard population) to 9.0. (Objective 15–15a) Reduce deaths from 2 per 100 million vehicle miles traveled (in 1997) to 1. (Objective 15–15b) Reduce nonfatal injuries caused by motor vehicle crashes from 1270 per 100,000 persons (in 1997) to 1000 (21% improvement). (Objective 15–17)	Reduce the number of fatal and nonfatal injuries by 20% by the year 2008 (from 42,065 fatal and 3,511,000 nonfatal injuries in 1996).[18]
Child Safety Seat Use	
Increase use of child restraint devices for passengers up to age 4 years, from 92% (1998 preliminary data) to 100%. (Objective 15–20)	Reduce child occupant fatalities (0–4 years) by 25% by 2005 (from 653 fatalities in 1996).[19]
Safety Belt Use	
Increase use of safety belts from 69% (in 1998) to 92% (33% improvement). (Objective 15–19)	Increase national seat belt use to 90% by 2005 (from 68% in 1996).[19]
Alcohol-Impaired Driving	
Reduce deaths caused by alcohol-related motor vehicle crashes from 6.1 per 100,000 persons (1997 baseline) to 4 per 100,000. (Objective 26–1a) Reduce injuries caused by alcohol-related motor vehicle crashes from 122 per 100,000 persons (1997 baseline) to 65 per 100,000. (Objective 26–1b) Reduce the proportion of adolescents who report that they rode, during the previous 30 days, with a driver who had been drinking alcohol, from 37% (in 1997) to 30%. (Objective 26–6) Extend administrative license revocation laws, or programs of equal effectiveness, for persons who drive under the influence of intoxicants, from 41 states (in 1998) to all states and the District of Columbia. (Objective 26–24) Extend legal requirement for maximum blood alcohol concentration levels of 0.08% for motor vehicle drivers aged ≥21 years, from 16 states (in 1998) to all states and the District of Columbia. (Objective 26–25)	Reduce alcohol-related fatalities to no more than 11,000 annually by 2005[20] (from 15,786 in 1999).[5]

achieve objectives set out in *Healthy People 2010*[12] and by the National Highway Traffic Safety Administration (Table 1).[5,18–20] In addition, the recommendations complement and add to information published by other groups. For example, the U.S. Preventive Services Task Force recommends counseling individual patients (including adults and parents of young children) to use occupant restraints (lap/shoulder safety belts and child safety seats), to wear helmets when riding motorcycles, and to refrain from driving while under the influence of alcohol or other drugs.[21] The American Academy of Pediatrics[22,23] (AAP; www.aap.org) suggests ways for pediatricians to implement office-based injury prevention counseling through The Injury Prevention Program (TIPP). The AAP also has model bills available, such as the Graduated Drivers' Licensing Act. The National Center for Injury Prevention and Control (Centers for Disease Control and Prevention) makes recommendations through the MMWR (Morbidity and Mortality Weekly Report; www.cdc.gov/mmwr/) on child safety seats, safety belts, and alcohol-impaired driving. Recommendations are also available from NHTSA,[24] the National Transportation Safety Board[25] (see also www.ntsb.gov), the American Medical Association,[26] and DHHS.[12]

Intervention Recommendations

The Task Force evaluated the evidence of effectiveness of 13 selected interventions to address three strategies for reducing injuries to motor vehicle occupants (Table 2): increasing the use of child safety seats, increasing the use of safety belts, and reducing alcohol-impaired driving. (See Zaza et al.[16] for an explanation of how these interventions were selected.) Evaluations of additional interventions are still in progress.

Interventions to Increase the Use of Child Safety Seats

Child safety seats can be extremely effective. When correctly installed and used, they reduce the risk of death by 70% for infants and by 47% to 54% for toddlers (aged 1–4 years) and reduce the need for hospitalization by 69% for children aged 4 years and

Table 2. Recommendations of the Task Force on Community Preventive Services for population-based interventions to reduce injuries to motor vehicle occupants

Intervention	Recommendation
Increasing child safety seat use	
Child safety seat laws	Strongly recommended
Community-wide information and enhanced enforcement campaigns	Recommended
Distribution and education programs	Strongly recommended
Incentive and education programs	Recommended
Education-only programs	Insufficient evidence
Increasing safety belt use	
Safety belt laws	Strongly recommended
Primary enforcement safety belt laws	Strongly recommended
Enhanced enforcement programs	Strongly recommended
Reducing alcohol-impaired driving	
.08% BAC laws	Strongly recommended
Lower BAC laws for young or inexperienced drivers	Recommended
Maintaining the minimum legal drinking age at 21 years	Strongly recommended
Sobriety checkpoints	Strongly recommended
Intervention training programs for servers of alcohol beverages	Recommended[a]

[a]Recommended when implemented as high-quality, face-to-face training, accompanied by strong management support.
BAC, blood alcohol concentration

younger.[27] This section describes the Task Force's recommendations regarding five interventions designed to increase the use of child safety seats. A detailed review of the evidence for this section can be found in the accompanying article.[13]

Child safety seat laws: Strongly recommended. Child safety seat laws require children traveling in motor vehicles to be restrained in federally approved child restraint devices (e.g., infant or child safety seats) appropriate for the child's age and size. The state laws, which vary widely, also specify the children to whom the law applies by age, height, weight, or a combination of these factors. Child safety seat laws are strongly recommended based on their effectiveness in reducing fatal and nonfatal injuries and increasing child safety seat use throughout the Unites States. No harms or other potential benefits were reported and no qualifying economic information was identified from the literature.

Community-wide information and enhanced enforcement campaigns: Recommended. Community-wide information and enhanced enforcement campaigns seek to promote use of safety seats through the use of mass media, mailings, child safety seat displays in public sites, and special enforcement strategies such as checkpoints, dedicated law enforcement officials, or alternative penalties. These campaigns target their information and activities to an entire community, usually geographic in nature. Community-wide information and enhanced enforcement campaigns are recommended on the basis that they increase child safety seat use in a variety of populations and settings. No harms or other potential benefits were reported and no qualifying economic information was identified from the literature.

Distribution and education programs: Strongly recommended. Through distribution and education programs, approved child safety seats are given, lent, or rented at low cost to parents. All programs also include educational components of varying intensities. These programs target parents and other caregivers who might need assistance in acquiring a safety seat because of financial hardship or poor understanding of the importance of using child safety seats.

Distribution and education programs are strongly recommended on the basis that they increase child safety seat use when implemented (1) in a range of settings; (2) in a variety of population subgroups; and (3) as loan, rental, or giveaway programs. In addition, one study indicated a reduction in injury insurance claims among a population provided with safety seats by an automobile insurance company. No harms or other potential benefits were reported and no qualifying economic information was identified from the literature.

An important implementation issue regarding distribution and education programs has arisen since the studies in this review were conducted. Because the integrity of child safety seats can be compromised in a crash, seats returned to a distribution and education program should not be lent to others because there can be no guarantee that they were not involved in a crash. Therefore, when implementing child safety seat distribution and education programs, only new, unused seats should be provided to all recipients.

Incentive and education programs: Recommended. Incentive and education programs (1) provide children and parents with rewards and opportunities for rewards for the purchase and correct use of child safety seats, and (2) include educational components of varying

intensities. Incentive and education programs are recommended based on their effectiveness in increasing child safety seat use in a variety of populations and settings and using various reward systems. No harms or other potential benefits were reported and no qualifying economic information was identified from the literature.

Education programs: Insufficient evidence. Education programs provide information and teach skills to parents, children, or professional groups about the use of child safety seats. Information provides the basic foundation for moving people toward behavior change and can enhance skills, thus enabling behavior change. Providing information alone is rarely sufficient for sustained behavior change, but it is a central and necessary component of other interventions, such as community campaigns, distribution programs, and incentive programs.

The Task Force identified three qualifying studies that evaluated the effect of perinatal safety seat education programs on parents' later use of the seats for their children, one qualifying study evaluating the effect of a preschool education program on children's safety seat use, and two qualifying studies evaluating the effect of professional education on provider and system performance in health care systems and law enforcement, respectively. Therefore, on the basis of the (1) small number of available studies, and (2) variability in the interventions evaluated, insufficient evidence exists to assess the effectiveness of education programs alone in increasing child safety seat use.

Interventions to Increase the Use of Safety Belts

Safety belt use is estimated to have saved 123,000 lives between 1975 and 1999. If all motor vehicle occupants consistently wore safety belts, it is estimated that an additional 9553 deaths would have been prevented in 1999 alone.[28] Lap and shoulder safety belts are the single most effective means for occupants to reduce the risk of death and serious injury in a crash. They have been shown to reduce deaths by 45% to 60%[29–31] and serious injury to the head, chest, and extremities by 50% to 83%.[30] Overall safety belt use in the United States is estimated to be 71%.[32] This section reports the Task Force's recommendations for three interventions to increase the use of safety belts. A detailed review of the evidence for this section can be found in the accompanying article.[14]

Safety belt laws: Strongly recommended. Safety belt laws require the use of safety belts by motor vehicle occupants. Specific requirements (e.g., age, seating position, fines, exceptions) vary by state. Safety belt laws are strongly recommended based on their effectiveness in increasing safety belt use and reducing fatal and nonfatal injuries among adolescents and adults. Several studies indicated the additional benefit that laws requiring adult safety belt use also increase safety belt use by children. A potential harm of safety belt laws can be found in the theory that safety belt use will lead to other unsafe driving behaviors, thus neutralizing any beneficial effect that their use might confer. No studies reviewed, however, have shown an association between safety belt laws and increases in unsafe driving behaviors. No qualifying economic information was identified from the literature.

Primary enforcement safety belt laws: Strongly recommended. Primary enforcement safety belt laws allow a police officer to stop a vehicle solely for an observed belt law violation. The Task Force strongly recommends these laws over secondary enforcement laws, which allow a police officer to issue a belt law citation only if the vehicle has been stopped for another violation. The strong recommendation is based on the superior effectiveness of primary enforcement safety belt laws in increasing safety belt use and reducing fatal injuries compared with secondary enforcement safety belt laws in the United States. Potential harms and other positive effects considered are similar to those for safety belt laws in general. In addition, although differential enforcement based on race or ethnicity has been reported as a concern, studies that looked for evidence of such differential enforcement found none. No qualifying economic information was identified from the literature.

Enhanced enforcement programs: Strongly recommended. Enhanced enforcement programs provide increased rather than routine enforcement of safety belt laws at specific locations and times. These programs always include a publicity component. Enhanced enforcement programs are strongly recommended based on their effectiveness in increasing safety belt use and reducing fatal and nonfatal injuries in a wide range of settings and among various populations. One program reported increased corollary arrests as an additional benefit of an enhanced enforcement program. No harms were reported and no qualifying economic information was identified from the literature.

Interventions to Reduce Alcohol-Impaired Driving

Alcohol-related motor vehicle crashes (i.e., those in which the driver had a blood alcohol concentration of at least 0.01 g/dL) resulted in 16,068 deaths and more than 300,000 injuries in 2000.[33] This section reports on the Task Force's recommendations regarding five interventions to reduce alcohol-impaired driving. A detailed review of the evidence for this section can be found in the accompanying article.[15]

0.08% blood alcohol concentration laws: strongly recommended. These laws establish the illegal blood alcohol concentration (BAC) of 0.08 g/dL for drivers aged 21 years and older (lower BAC levels are established for drivers 20 years old and younger). The 0.08% BAC laws are strongly recommended based on their effectiveness in reducing alcohol-related crash fatalities in the United States. No harms or other potential benefits were reported and no qualifying economic information was identified from the literature.

Laws that establish a lower BAC level for young and inexperienced drivers: recommended. These laws establish a lower BAC level for young or inexperienced drivers than for older or more experienced drivers, making it illegal for the persons targeted by the law to drive with a BAC above the established limit. In the United States, the limit is 0.02% or lower, and these laws apply to all persons under the age of 21 years (the minimum legal drinking age [MLDA] in all states). In other countries, these laws apply to either newly licensed drivers or newly licensed drivers under a specified age. The Task Force recommends laws establishing a lower legal BAC for young or inexperienced drivers based on their effectiveness in reducing alcohol-related crashes in the United States and Australia. A potential harmful effect of these laws is that young drivers whose BACs exceed the legal limit for adult drivers (0.08 g/dL or 0.10 g/dL) may receive "zero tolerance" citations instead of being arrested for the more serious offense of driving under the influence of alcohol. One study reported an estimated benefit-to-cost ratio of $11 per dollar invested for lower legal BAC limits for young drivers.

Maintaining the minimum legal drinking age at 21 years: strongly recommended. MLDA laws specify an age below which the purchase and consumption of alcoholic beverages are not permitted. This review examined the effect of raising or lowering the MLDA. All states currently have an MLDA of 21 years. Maintaining or implementing the MLDA at 21 years rather than at a younger age is strongly recommended based on evidence from the United States, Canada, and Australia that the higher age requirement for legal drinking is effective in decreasing alcohol-related crashes and associated injuries among 18- to 20-year-old drivers. Other potential benefits include decreased alcohol consumption. No harms were reported and no qualifying economic information was identified from the literature.

Sobriety checkpoints: strongly recommended. Sobriety checkpoints are designed to systematically stop drivers to assess their level of alcohol impairment. The goal is to deter alcohol-impaired driving by increasing the perceived risk of arrest. There are two types of sobriety checkpoints. At random breath testing (RBT) checkpoints, all drivers are stopped and tested for blood alcohol levels. RBT checkpoints are common in Australia and several European countries. In the United States, selective breath testing (SBT) checkpoints are used. At these checkpoints, police must have a reason to suspect that the driver has been drinking (i.e., probable cause) before testing blood alcohol levels. Sobriety checkpoints are strongly recommended based on their effectiveness in reducing alcohol-impaired driving, alcohol-related crashes, and associated fatal and nonfatal injuries in a variety of settings and among various populations. Corollary arrests are a potential added benefit. The brief intrusion this entails into drivers' privacy is generally considered justified by the public interest served by checkpoints. Four economic studies were identified, all of which indicated sizeable economic benefits.

Intervention training programs for servers of alcoholic beverages: recommended, when conducted as high-quality face-to-face training, accompanied by strong management support, there is insufficient evidence of the effectiveness of community-wide programs.

Server intervention training programs provide education and training to servers of alcoholic beverages with the goal of altering their serving practices to prevent patron intoxication and alcohol-impaired driving. These practices can include offering food with drinks, delaying service to rapid drinkers, refusing service to intoxicated patrons, and discouraging intoxicated patrons from driving.

Server intervention training programs are recommended on the basis of evidence that high-quality face-to-face training, when accompanied by strong management support, is effective in reducing the level of intoxication among patrons. The evidence on which this recommendation is based comes primarily from small-scale studies in which the participants may have been unusually motivated and the researchers had a high degree of control over the implementation of the server training. Although these findings are promising, they may not apply to larger, community-wide server training programs for which evidence is insufficient. No qualifying economic information was identified for either type of program.

Interpreting and Using the Recommendations

Given that motor vehicle occupant injuries are the leading cause of injury death among people aged 1–34 in the United States,[34] reducing the number of motor vehicle crashes and crash-related occupant injuries should be relevant to most communities. States and communities can compare their current motor vehicle injury prevention interventions and activities with recommendations in this report. They can then take steps to ensure that existing interventions are adequately

implemented and funded, while considering implementation of other recommended interventions.

The Task Force recommendations can be used to support or expand child safety seat distribution programs, bolster the use of incentives, and employ enhanced enforcement campaigns, all in conjunction with community-wide education efforts. For example, the recommendation for child safety seat distribution and education programs might inform a community's decision to concentrate the distribution of low-cost or no-cost child safety seats in low-income neighborhoods, or to seek local sponsorship to defray the costs of seats distributed to needy families. In selecting and implementing interventions, communities should strive to develop a comprehensive program to reduce motor vehicle occupant injuries that adopts interventions from each of the three strategic areas and includes various intervention types, for example legislation, enforcement, public education, training, and other community-oriented strategies. If appropriately implemented, each of the approaches will contribute to reductions in occupant injury-related morbidity and mortality, and success in one area could contribute to improvements in the other areas as well.

The Task Force recommended or strongly recommended six state public health laws. Of those, three are already in effect in all 50 states (i.e., laws requiring use of child safety seats, lower legal BAC for young or inexperienced drivers, and an MLDA of 21 years). In addition, 49 states have laws requiring use of safety belts (New Hampshire has no such law). As of May 1, 2001, the other laws reviewed by the Task Force—0.08% BAC laws and primary enforcement safety belt laws—had been enacted in 24 states and 17 states, respectively, plus Washington, DC and Puerto Rico. In support of 0.08% BAC laws, the U.S. Congress included a provision in the 2001 Department of Transportation and Related Agencies Appropriations Act[35] requiring states to implement 0.08% BAC laws by fiscal year 2004 or risk losing federal highway construction funds.

The Task Force recommendations can be used to promote the adoption, maintenance, or strengthening of state or national laws or regulations. For example, at the state level, injury control program directors can use these recommendations to develop testimony about the effectiveness of different traffic safety laws for presentation to state legislatures. State legislators and their staff members can use the recommendations as they draft, debate, and vote on new or amended legislation. Advocacy and community groups, both local and national, can use the information to develop position statements about pending legislation. Health agencies can help educate the community about the importance and effectiveness of the laws and their enforcement. Health maintenance organizations can apply the findings from these reviews to the populations they care for, and can also use them to direct their involvement in the broader community and to direct the involvement of their foundations.

Choosing interventions that work in general and that are well-matched to local needs and capabilities, then carefully implementing those interventions, are vital steps in improving use of child safety seats and safety belts and deterring alcohol-impaired driving. In setting priorities for the selection of interventions to meet local objectives, recommendations and other evidence provided in the *Community Guide* should be considered along with such local information as resource availability; administrative structures; and economic, social, and regulatory environments of organizations and practitioners. It is often useful to involve other partners in these efforts, such as each state's Governor's Office of Highway Safety, directors of state injury control programs in health departments (www.stipda.org), or local chapters of the National SAFE KIDS Campaign (www.safekids.org), the National Safety Council (www.nsc.org), and Mothers Against Drunk Driving (www.madd.org). Additional information about applicability and economic information can be found in the accompanying articles.[13–15] Taking into consideration local goals and resources, the use of strongly recommended and recommended interventions should be given priority for implementation or enforcement.

References

1. National Center for Injury Prevention and Control. Working to prevent and control injury in the United States: fact book for the year 2000. Atlanta, Georgia: Centers for Disease Control and Prevention, 2000:5–11.
2. Rosenberg HM, Ventura SJ, Maurer JD, Heuser RL, Freedman MA. Births and deaths: United States, 1995. Monthly Vital Stat Rep 1996;45:1–35.
3. Fingerhut LA, Warner M. Injury chartbook. Health, United States, 1996–97. Hyattsville, MD: National Center for Health Statistics, 1997.
4. Sleet DA, Rosenberg ML. Injury control. In: Scutchfield D, Keck W, eds. Principles of public health practice. Albany, NY: Delmar Publishers, 1997:337–49.
5. National Highway Traffic Safety Administration. Traffic safety facts, 1999: a compilation of motor vehicle crash data from the Fatality Analysis Reporting System and the General Estimates System. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 100.
6. Stussman BJ. National hospital ambulatory medical care survey: 1993 emergency department summary. Hyattsville, MD: National Center for Health Statistics, Centers for Disease Control and Prevention, 1996. No. 271.
7. Blincoe L. Economic costs of motor vehicle crashes, 1994. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1996. DOT HS 808 425.
8. National Safety Council. Accident facts, 1998 edition. Itasca, IL: National Safety Council, 1998.
9. Centers for Disease Control and Prevention. Motor vehicle safety: a 20th century public health achievement. MMWR 1999;48:369–74.
10. National Center for Injury Prevention and Control. Prevention of motor vehicle-related injuries: a compendium of articles from the Morbidity and Mortality Weekly Report 1985–1996. Atlanta, GA: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, 1997.
11. Sleet DA. Reducing motor vehicle trauma through health promotion programming. Health Educ Q 1984;11:113–25.
12. U.S. Department of Health and Human Services. Healthy People 2010, 2nd ed. With understanding and improving health and objectives for improving health, 2 vols. Washington, DC: U.S. Government Printing Office, 2000.

13. Zaza S, Sleet DA, Thompson RS, Sosin DM, Bolen JC, Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of child safety seats. Am J Prev Med 2001;21(suppl 4):31–47.
14. Dinh-Zarr TB, Sleet DA, Shults RA, et al., and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of safety belts. Am J Prev Med 2001;21(suppl 4):48–65.
15. Shults RA, Elder RW, Sleet DA, et al., and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to reduce alcohol-impaired driving. Am J Prev Med 2001;21(suppl 4):66–88.
16. Zaza S, Carande-Kulis VG, Sleet DA, et al., and the Task Force on Community Preventive Services. Methods for conducting systematic reviews of the evidence of effectiveness and economic efficiency of interventions to reduce injuries to motor vehicle occupants. Am J Prev Med 2001;21(suppl 4):23–30.
17. Briss PA, Zaza S, Pappaioanou M, et al. Developing an evidence-based Guide to Community Preventive Services—methods. Am J Prev Med 2000;18(suppl 1):35–43.
18. National Highway Traffic Safety Administration. Promoting safe passage into the 21st century, strategic plan 1998. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1998. Available at: www.nhtsa.dot.gov/nhtsa/whatis/planning/StratPlan.1998. Accessed September 6, 2001.
19. National Highway Traffic Safety Administration. Presidential initiative for increasing seat belt use nationwide: recommendations from the Secretary of Transportation. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1997. DOT HS 808 576.
20. National Highway Traffic Safety Administration. 11000 by 2005: Partners In Progress: an impaired driving guide for action. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1997. DOT HS 808 365.
21. U.S. Preventive Services Task Force. Guide to Clinical Preventive Services: report of the U.S. Preventive Services Task Force, 2nd ed. Baltimore: Williams & Wilkins, 1996.
22. American Academy of Pediatrics. Selecting and using the most appropriate car safety seats for growing children: guidelines for counseling parents (RE9618). 2000. www.aap.org/policy/01352.html. Accessed January 10, 2001.
23. American Academy of Pediatrics. The teenage driver (RE9642). 2000. www.aap.org/policy/re9643.html. Accessed January 10, 2001.
24. National Highway Traffic Safety Administration. Highway safety program advisories. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1990. DOT HS 807 655.
25. National Transportation Safety Board. We are all safer—NTSB-inspired improvements in transportation safety, 2nd ed. 1998. www.ntsb.gov/Publictn/1998/SR9801.pdf. Accessed January 10, 2001.
26. American Medical Association. Operating vehicles under the influence of alcohol or other drugs/underage drinking and driving. 2000. Available at: www.ama-assn.org/ama/pub/article/3342-3637.html. Accessed September 6, 2001.
27. National Highway Traffic Safety Administration. Buckle Up America: The presidential initiative for increasing seat belt use nationwide. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1998. DOT HS 808 879.
28. National Highway Traffic Safety Administration. Traffic safety facts 1999: occupant protection. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 090.
29. Evans L. The effectiveness of safety belts in preventing fatalities. Accid Anal Prev 1986;18:229–41.
30. National Highway Traffic Safety Administration. Fourth report to Congress: Effectiveness of occupant protection systems and their use. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1999. DOT HS 808 919.
31. Morgan C. Effectiveness of lap/shoulder belts in the back outboard seating positions. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1999. DOT HS 808 945.
32. National Highway Traffic Safety Administration. Observed safety belt use from December 1999 and June 2000. MiniNOPUS. Research Note. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000.
33. National Highway Traffic Safety Administration. National Center for Statistics and Analysis. 2000 early assessment. Motor vehicle traffic crash fatality and injury estimates for 2000. 2001. Available at: www.nhtsa.dot.gov/people/ncsa/pdf/2Kassess_rev4.pdf. Accessed June 8, 2001.
34. Pickle LW, Mungiole M, Jones GK, White AA. Atlas of United States mortality. Hyattsville, MD: National Center for Health Statistics, 1996. DHHS Pub No (PHS) 97-1015.
35. Department of Transportation and Related Agencies Appropriations Act, 2001. Pub. L. No. 106-346, 2000.

Methods for Conducting Systematic Reviews of the Evidence of Effectiveness and Economic Efficiency of Interventions to Reduce Injuries to Motor Vehicle Occupants

Stephanie Zaza, MD, MPH, Vilma G. Carande-Kulis, PhD, MS, David A. Sleet, PhD, MA, Daniel M. Sosin, MD, MPH, Randy W. Elder, MEd, Ruth A. Shults, PhD, MPH, Tho Bella Dinh-Zarr, PhD, MPH, James L. Nichols, PhD, Robert S. Thompson, MD, and the Task Force on Community Preventive Services

Background: Motor vehicle occupant injury prevention is included in the *Guide to Community Preventive Services* because of the enormous health impact of these largely preventable injuries. This article describes the methods for conducting systematic literature reviews of interventions for three key injury prevention strategies: increasing child safety seat use, increasing safety belt use, and decreasing alcohol-impaired driving.

Methods: Systematic review methods follow those established for the *Guide to Community Preventive Services* and include: (1) recruiting a systematic review development team, (2) developing a conceptual approach for selecting interventions and for selecting outcomes that define the success of the interventions, (3) defining and conducting a search for evidence of effectiveness, (4) evaluating and summarizing the body of evidence of effectiveness, (5) evaluating other potential beneficial and harmful effects of the interventions, (6) evaluating economic efficiency, (7) identifying implementation barriers, (8) translating the strength of the evidence into recommendations, and (9) identifying and summarizing research gaps.

Results: The systematic review development team evaluated 13 interventions for the three strategic areas. More than 10,000 titles and abstracts were identified and screened; of these, 277 met the a priori systematic review inclusion criteria. Systematic review findings for each of the 13 interventions are provided in the accompanying articles in this supplement.

Conclusion: The general methods established for conducting systematic reviews for the *Guide to Community Preventive Services* were successfully applied to interventions to reduce injuries to motor vehicle occupants.

Medical Subject Headings (MeSH): accidents, traffic; alcohol drinking; motor vehicles; wounds and injuries; seat belts; community health services; decision making; evidence-based medicine; economics; preventive health services; public health practice (Am J Prev Med 2001;21(4S):23–30)

Introduction

The U.S. Task Force on Community Preventive Services (the Task Force) chose the topic "motor vehicle occupant injury prevention" for inclusion in the *Guide to Community Preventive Services* (the *Community Guide*) because of the enormous health impact of motor vehicle occupant injuries. In addition, motor vehicle occupant injuries are largely preventable. The Task Force sought evidence of the effectiveness of interventions to prevent these injuries by using systematic review methods.

The *Community Guide*'s methods for conducting systematic reviews and for linking evidence to recommendations have been described elsewhere.[1,2] In brief, for each *Community Guide* topic, a diverse team representing a range of disciplines, backgrounds, experiences, and work settings conducts a review by:

- developing a conceptual framework for organizing, grouping, and selecting the interventions for the health issues under consideration and for choosing the outcomes used to define success for each intervention;

From the Division of Prevention Research and Analytic Methods, Epidemiology Program Office, (Zaza, Carande-Kulis), Division of Unintentional Injury Prevention (Shults, Elder, Sleet, Dinh-Zarr), and Office of the Director (Sosin), National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, Georgia; Office of Research and Traffic Records, National Highway Traffic Safety Administration (Nichols), Washington, DC; Task Force on Community Preventive Services and The Department of Preventive Care, Group Health Cooperative of Puget Sound (Thompson), Seattle, Washington

Address correspondence and reprint requests to: Stephanie Zaza, MD, MPH, Community Guide Branch, Centers for Disease Control and Prevention, 4770 Buford Highway, MS-K73, Atlanta, GA 30341. E-mail: szaza@cdc.gov.

The names and affiliations of the Task Force members are listed in the front of this supplement and at www.thecommunityguide.org.

0749-3797/01/$–see front matter
PII S0749-3797(01)00379-8

- systematically searching for and retrieving evidence;
- assessing the quality of and summarizing the strength of the body of evidence of effectiveness;
- summarizing information about other evidence; and
- identifying and summarizing research gaps.

This report describes the specific methods used in the systematic literature reviews to determine the effectiveness of interventions to reduce motor vehicle occupant injuries.

Systematic Review Development Team

Three groups of individuals served on the systematic review development team:

- The coordination team—consisting of a Task Force member, methodologic experts in systematic reviews and economics from the Community Guide Branch (Epidemiology Program Office, Centers for Disease Control and Prevention [CDC]), and motor vehicle crash injury experts from the National Center for Injury Prevention and Control (CDC) and the National Highway Traffic Safety Administration (NHTSA)—drafted the conceptual framework for the reviews, managed the data collection and review process, and drafted evidence tables, summaries of the evidence, and the reports.
- The consultation team reviewed and commented on materials developed by the coordination team and set priorities for the reviews. The consultants are motor vehicle injury experts in state and local public health settings, academic organizations, federal agencies, and voluntary organizations. These experts have backgrounds in medicine, public health, economics, health promotion intervention design and implementation, health education, health policy, and epidemiology.
- The abstraction team collected and recorded data from studies for possible inclusion in the systematic reviews. (See Evaluating and Summarizing the Studies, below.) This team included some members of the coordination and consultation teams as well as graduate students and preventive medicine residents.

Unless otherwise noted, in this report and in the articles presenting the results of the reviews[3–5] the term "team" refers to the coordination and consultation teams only, because the abstraction team's role was limited to collecting and recording data.

Conceptual Approach

When developing the systematic reviews, the team first created a conceptual framework that included the following elements:

- A graphic illustration of the problem of motor vehicle occupant injuries and the modifiable determinants of those injuries. In these reports, we refer to this illustration as the logic framework (Figure 1);
- A list of candidate interventions to reduce motor vehicle occupant injuries (Table 1);
- The criteria used to select interventions for review;
- The final list of interventions evaluated; and
- The outcomes for which evidence was to be sought and those that were to be used to define success and result in recommendations.

Logic Framework

To develop the logic framework, the team first illustrated the following pathway by which motor vehicle occupants are injured in crashes:

- People have access to and use vehicles;
- Some are involved in a crash;
- Energy is transferred from the vehicle to its occupants; and
- Injuries may occur if the energy transferred is greater than the physiologic and anatomic capacity of the occupants.

The team then added the modifiable determinants of those injuries on which interventions act. These determinants affect the pathway and each other by the following complex and interrelated mechanisms:

- characteristics of populations (e.g., driving behaviors or specific risk factors such as age);
- characteristics of public health, health care, or legislative systems (including enforcement);
- physical environment factors (e.g., roadways); and
- vehicle factors (e.g., presence of air bags).

Candidate Interventions

Using the logic framework, the team generated a list of candidate interventions for inclusion (Table 1). They listed interventions addressing each of the modifiable determinants (i.e., population factors, systems, physical environment, and vehicles). These interventions were grouped into strategies according to similar behaviors or risk factors. The logic framework and list of candidate interventions were based, in part, on Haddon's matrix.[6]

Criteria for Selecting Interventions for Review

In these reviews, the team decided to exclude strategies that focus on changing motor vehicles themselves or other aspects of the physical environment. This decision was made because the resources for implementing such interventions might not be readily available to the primarily public health–oriented audience of the *Community Guide*. The team ranked the remaining strategies on the basis of the likelihood that the included inter-

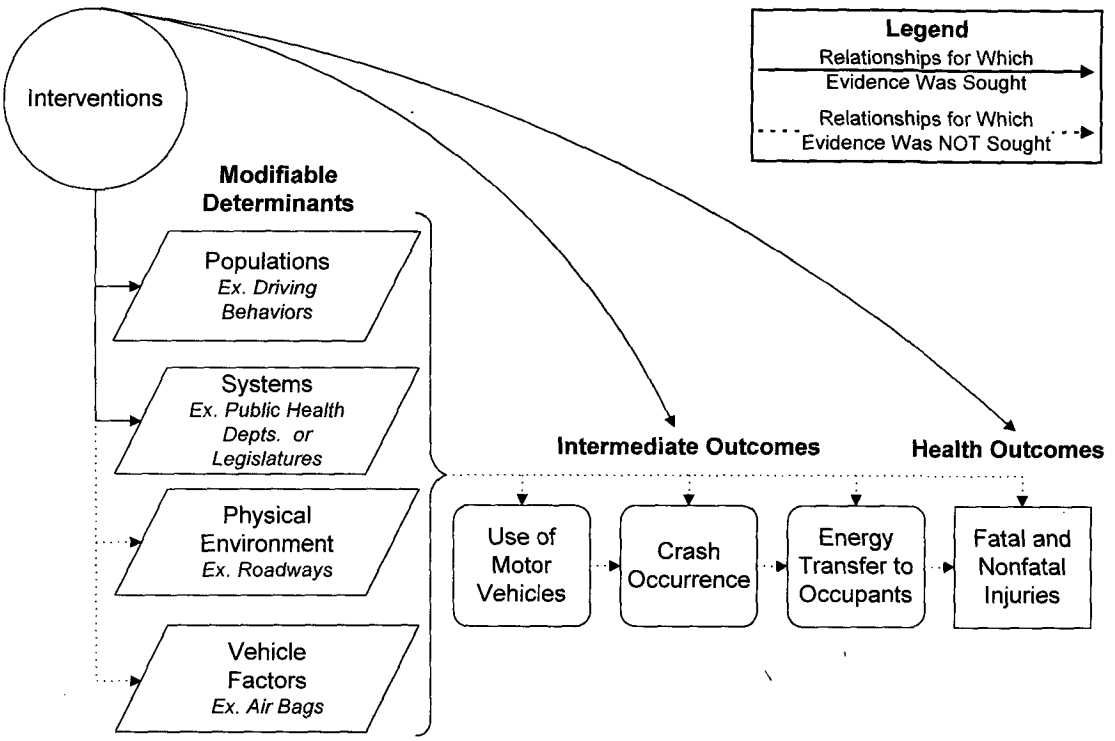


Figure 1. Logic framework illustrating the links among interventions, modifiable determinants of motor vehicle crash injuries, and intermediate and health outcomes.

ventions could reduce the injury burden. On the basis of the team's recommendations, the Task Force selected for review three strategies: to promote use of child safety seats, to promote use of safety belts, and to deter alcohol-impaired driving. These strategies were chosen because (1) use of child safety seats and use of safety belts are below national goals[7]; (2) 38% of traffic deaths involve alcohol[8]; and (3) not using child safety seats, not using safety belts, and alcohol-impaired driving are among the most important contributors to motor vehicle occupant injuries.

Within each of these three strategies, the development team generated a comprehensive list of interventions. From this list, they created a priority list of interventions for review after polling consultants and other experts about their perception of the importance and practicality of the various interventions. Interventions reviewed were either single component (i.e., using only one activity to achieve desired outcomes) or multicomponent (i.e., using more than one related activity). The specific interventions chosen for review are described in each of the accompanying evidence review articles.[3–5]

Analytic Frameworks

An analytic framework was designed for each of the interventions in the three strategies chosen for review to illustrate the key health and other outcomes that might result from the intervention (and on which the literature search was to concentrate), the potential effect measures for each of those outcomes, and the likely target populations and settings for the intervention. These analytic frameworks helped to define the study questions of interest for the intervention, the key terms to be used in searching for evidence, and the criteria for studies to be included in the evidence base for the intervention.

Specific outcome and effect measures used for determining effectiveness are described in each of the accompanying evidence review articles.[3–5] For all three strategies, the outcomes that were chosen to indicate effectiveness included reductions in injury rates (both fatal and nonfatal) and improvements in behavioral outcomes (i.e., use of child safety seats, use of safety belts, and alcohol-impaired driving). Improvements in behavioral outcomes were deemed acceptable by the team because of the following reasons:

- Child safety seats are 55% to 70% effective in preventing deaths[9];
- Safety belts are 45% to 60% effective in preventing deaths and 50% to 65% effective in reducing moderate-to-critical injury[10]; and
- The risk of involvement in a single-vehicle fatal crash nearly doubles with each 0.02 g/dL increase in blood alcohol concentration (e.g., from 0.08% to 0.10%).[11]

Table 1. *List of candidate interventions to reduce motor vehicle occupant injuries*

Population Interventions

Alcohol-specific education
- Police department campaigns (e.g., putting a wrecked vehicle in front of a school)
- Prom night campaigns/drug-free pledges
- Designated driver programs

Restraint use interventions
- Child-restraint device distribution programs
- Prenatal counseling or education programs (e.g., in birthing or breast-feeding classes)
- Mass-media campaigns

Interventions aimed at teenaged drivers
- Education for risk recognition
- Education for risk reduction
- Graduated licensing
- Older minimum driving age
- Organized competitions for rational driving skills
- Curfews
- Required drivers' education for licensing

Interventions aimed at elderly drivers
- Recognition of risk of failing eyesight with education to decrease nighttime driving and speed
- Yearly license renewal with eye exam and driving test

Speed control interventions
- Individual feedback for speed reduction
- Speed reduction education campaigns

System Interventions

Alcohol-specific regulation
- License revocation after DUI
- Sobriety checkpoints
- Sales restrictions
- Mandatory treatment for DUI
- Lower blood alcohol limit
- Targeted, highly visible enforcement
- Brief interventions for alcohol use in trauma centers
- Increase BAC testing in trauma centers
- Tow-away of vehicles for convicted DUI offenders

Restraint use regulation
- Mandatory seat belt laws
- Mandatory child restraint laws
- Mandatory prenatal class education
- Targeted, highly visible enforcement

Community mobilization/social marketing to lobby and gain acceptance for any other intervention

Speed control interventions
- Speed limits
- Video camera surveillance and ticketing

EMS, trauma, and hospital
- Reduce response and transport times
- Enforcement of laws requiring yield to emergency vehicles
- Increase EMS training levels
- Increase funding for EMS and trauma at the local level
- Community volunteerism for Bystander Care programs through local EMS providers (e.g., first aid)

Physical Environment Interventions

Increase availability and acceptability of public transportation
- Free or reduced evening fares
- Increase the number of facilities
- Ensure safety at facilities

Roadway modifications
- Removal of immobile objects from roadsides
- Speed bumps
- Traffic circles

Vehicle Factor Interventions

Vehicle modifications
- Built-in restraints
- Ignition interlock
- Raised brake lights
- Antilock brakes
- Air bags
- Passive restraints
- Side impact protection

BAC, blood alcohol concentration; DUI, driving under the influence; EMS, emergency medical services

Search Strategy

The reviews of interventions to reduce motor vehicle occupant injury reflect systematic searches of multiple databases as well as reviews of reference lists and consultations with experts in the field. Specific search strategies and inclusion criteria are provided in each of the accompanying evidence review articles.[3–5] The team searched six computerized databases (MEDLINE, Embase, Psychlit, Sociological Abstracts, EI Compendex, and Transportation Research Information Services [TRIS]),which yielded 10,958 titles and abstracts for screening. Studies were eligible for inclusion if:

- they were published from the originating date of the database through June 2000 (March 1998 for child safety seat interventions);
- they involved primary studies, not guidelines or reviews;
- they were published in English;
- they were relevant to the interventions selected for review;
- the evaluation included a comparison to an unexposed or less-exposed population; and
- the evaluation measured outcomes defined by the analytic framework for the intervention.

After screening titles and abstracts, 3653 papers were collected for further screening and 277 of these papers ultimately met the inclusion criteria.

Individual studies were grouped together on the basis of the similarity of the interventions being evaluated and were analyzed as a group. Some studies provided evidence for more than one intervention. In those cases, the studies were reviewed for each applicable intervention. Interventions and outcome measures were classified according to definitions developed as part of the review process. The classification and nomenclature used in the systematic reviews sometimes differs from that used in the original studies.

Evaluating and Summarizing the Studies

Each study that met the inclusion criteria was evaluated by using a standardized abstraction form (available at www.thecommunityguide.org) and was assessed for suitability of the study design and threats to validity.[1] On the basis of the number of threats to validity, studies were characterized as having good, fair, or limited execution.[1,12] Studies with limited execution were not included in the summary of the effect of the intervention. The remaining studies (i.e., those with good or fair execution) were considered "qualifying studies." Estimates of effectiveness are based on those studies.

For studies that reported multiple measures of a given outcome, consistently applied rules were used to select the "best" measure with respect to validity and precision. Measures that were adjusted for the effects of potential confounders were used in preference to crude effect measures. For studies with concurrent comparison groups, net effects were derived when possible by calculating the difference between the changes observed in the intervention and comparison groups. A median was calculated as a summary effect measure for each outcome of interest. For reporting bodies of evidence consisting of seven or more studies, an interquartile range is presented as an index of variability; otherwise a simple range is reported.

Bodies of evidence of effectiveness were characterized as strong, sufficient, or insufficient on the basis of the number of available studies, the suitability of study designs for evaluating effectiveness, the quality of execution of the studies, the consistency of the results, and the effect size.[1]

Other Effects

The *Community Guide* systematic reviews of interventions to reduce motor vehicle occupant injury routinely sought information on other effects (i.e., positive and negative health or nonhealth "side effects"). Evidence of potential harms of these interventions was sought if they were mentioned in the effectiveness literature or if the team thought they were important. For example, in the reviews of child safety seat interventions, the team specifically sought information about the effect of the interventions reviewed on the incorrect use of the devices. Likewise, for reviews of legislative interventions to increase safety belt use, the team sought information about compensating behaviors that might increase risk and thereby negate the protective effects of the intervention (e.g., speeding, following distance). And, in interventions to reduce alcohol-impaired driving, the team sought information about potential infringement on civil rights.

Evaluating Economic Efficiency

For all interventions that are recommended or strongly recommended by the Task Force, the team conducted systematic reviews of the evidence of economic efficiency (see Appendix).[1,2] These reviews are provided to help decision makers choose among recommended interventions.

The general methods for conducting systematic reviews of economic efficiency have been previously reported[2] and are summarized here as they were adapted for the review of interventions to prevent motor vehicle occupant injury. The four basic steps are the following:

- searching for and retrieving evidence,
- abstracting and adjusting the economic data,
- assessing the quality of the identified economic evidence, and
- summarizing and interpreting the evidence of economic efficiency.

Searching for and Retrieving Economic Evidence

The databases MEDLINE, TRIS, CHID, NTIS, Embase, EI Compendex, PsycINFO, Social Science Search, Sociological Abstracts, ECONLIT, and Dissertation Abstracts were searched for the period 1970–1998. In addition, the references listed in all retrieved articles were reviewed and experts were consulted. Most of the included studies were either government reports or were published in journals. To be included in the review a study had to:

- be a primary study rather than, for example, a guideline or review;
- take place in an Established Market Economy[a];
- be written in English;
- meet the team's definitions of the recommended and strongly recommended interventions;
- use economic analytical methods such as cost analysis, cost–effectiveness analysis, cost–utility, or cost–benefit analysis (see Appendix); and
- itemize program costs and costs of illness or injury averted.

Abstracting and Adjusting the Economic Data

Two reviewers read each study that met the inclusion criteria. Any disagreements between the reviewers were reconciled by consensus of the team members. A standardized abstraction form (available at www.the

[a] Established Market Economics as defined by the World Bank include Andorra, Australia, Austria, Belgium, Bermuda, Canada, Channel Islands, Denmark, Faeroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Holy See, Iceland, Ireland, Isle of Man, Italy, Japan, Liechtenstein, Luxembourg, Monaco, The Netherlands, New Zealand, Norway, Portugal, San Marino, Spain, St. Pierre and Miquelon, Sweden, Switzerland, the United Kingdom, and the United States.

Table 2. *Example of economics summary table*

-Authors -Authors Affiliation -Funding Source -Pub. Date, -Study Period	-Method -Reported or Calculated Summary Measure	-Study Location, -Setting Type, -Population Description, -Follow-up Period	-Interventions Studied -Comparisons	-Reported Currency and Base Year -Costs Included -Benefits Included -Reported Summary Measure -Reported Effect Size	-Adjusted Currency and Base Year -Adjusted Value Summary Measure -Benefit/cost ratio -Notes	-Quality Category -Quality Score -Notes
Sobriety Checkpoints - Selective Breath Testing						
-Miller, TR -Children's Safety Network *Economics &* Insurance Resource Center -Not reported -1998 -Not reported	-Cost benefit analysis -Net benefit (annual)	-United States -Hypothetical community -100,000 licensed drivers -Not reported	-A hypothetical one-year campaign of intensive, four-hour sobriety checkpoints, 156 checkpoints per year, at a staffing level of 10 officers per checkpoint (BAC>.10%) -No comparison group	-1993 US dollars -Costs included personnel, equipment, travel delay, trial and punishment, mobility loss. -Benefits included averted medical care costs, property damage, future earnings, and quality of life -Benefits: $7.90 million Costs: $1.37 million Net benefit: $6.52 million -Effect size[a]: 15% reduction in alcohol-attributable crashes	-1997 US dollars (annual) -Benefits: $9.2 million Costs: $1.6 million Net benefit: $7.6 million -Benefit/cost ratio[b]: $6	-Very good -94 -Note: This study uses survival value from 50 willingness-to-pay studies.

[a] This effect size is an estimate by the authors based on a literature review, which suggested that a generously funded, intensive checkpoint program can be expected to reduce alcohol-attributable crashes by about 15%.

[b] Benefit/cost ratios are provided as a stand-alone piece of information and should not be used to rank interventions unless (1) there is a known budget constraint; (2) the interventions are mutually independent; and (3) interventions exhibit constant returns to scale (an increase in intervention inputs yields an equivalent increase in output).

communityguide.org) was used for abstracting data. For those studies conducting cost-effectiveness and cost–utility analysis, results were adjusted to approximate the analysis to the reference case suggested by the Panel on Cost-effectiveness in Health and Medicine.[13] Results from cost–benefit analyses were adjusted for currency and base-year only. When feasible, results were recalculated if the discount rate used in the study was other than 3%.

Assessing the Quality of the Evidence

Quality of study design and execution was systematically assessed across five categories: study design, cost data, outcome measure, effects, and analysis. By subtracting points for each limitation from a perfect score of 100, study quality was characterized as very good (90–100), good (80–89), satisfactory (60–79), or unsatisfactory (less than 60). Results from unsatisfactory studies were not presented.

Summarizing the Body of Evidence

The findings about the economic efficiency of interventions are presented in summary tables. The summary tables include information on seven aspects of each included study. Table 2 provides an example of a summary table.

Ratios or net present values (i.e., the discounted net benefit or net cost obtained from cost–benefit analysis) are pooled in ranges in those cases in which the intervention definition, population at risk, and comparator match across studies.

Barriers

Information about barriers to implementation of the interventions was abstracted from reviewed studies, evaluated on the suggestion of the team, or both. Information on barriers did not affect recommendations of the Task Force but is provided to assist readers contemplating implementation of the interventions.

Translating Strength of Evidence into Recommendations

The Task Force recommendations presented in the accompanying article[14] are based on the evidence gleaned from the systematic reviews conducted in accordance with these methods. The strength of each recommendation is based on the strength of the evidence of effectiveness (e.g., an intervention is "strongly recommended" when there is strong evidence of effectiveness, and an intervention is "recommended" when there is sufficient evidence).[1] Other types of evidence can also affect a recommendation. For example, evidence of harms resulting from an intervention might lead to a recommendation that the intervention not be used if adverse effects outweigh improved outcomes. In general, the Task Force does not use economic information to modify recommendations.

A finding of insufficient evidence of effectiveness should not be seen as evidence of ineffectiveness. It is important for identifying areas of uncertainty that require additional research. In contrast, adequate evidence of ineffectiveness leads to a recommendation that the intervention not be used.

Summarizing Research Gaps

Systematic reviews in the *Community Guide* identify existing information on which to base public health decisions about implementing interventions. An important additional benefit of these reviews is identification of areas in which information is lacking or of poor quality. To summarize these research gaps, remaining research questions for each intervention evaluated were first identified. Where evidence of effectiveness of an intervention was sufficient or strong, remaining questions about effectiveness, applicability, other effects, economic consequences, and barriers were summarized. Where evidence of effectiveness of an intervention was insufficient, remaining questions about only effectiveness and other effects were summarized. Applicability issues were summarized only if they affected the assessment of effectiveness. The team decided that it would be premature to identify research gaps in economic evaluations or barriers before effectiveness was demonstrated.

For each category of evidence, issues that had emerged from the review were identified, based on the informed judgment of the team. Several factors influenced that judgment. When a conclusion was drawn about evidence, the team decided if additional issues remained. Specifically,

- If effectiveness was demonstrated by using some but not all outcomes, all other possible outcomes were not necessarily listed as research gaps.
- If the available evidence was thought to be generalizable, all subpopulations or settings where studies had not been done were not necessarily identified as research gaps.
- Within each body of evidence, the team considered whether there were general methods issues that would improve future studies in that area.

The Reviews of Evidence

This article describes the general methodologic approach used in the systematic reviews of interventions to reduce motor vehicle occupant injury. The accompanying articles[3–5] present the supporting evidence on which the Task Force based its recommendations about these interventions.[14] Each article describes the scope and extent of the problem studied, discusses the conceptual approach to the review of evidence for the interventions studied, and presents additional information about methodology specific to the review of those interventions, in addition to giving a detailed report on the findings for each intervention.

References

1. Briss PA, Zaza S, Pappaioanou M, et al. and the Task Force on Community Preventive Services. Developing an evidence-based Guide to Community Preventive Services—methods. Am J Prev Med 2000;18(suppl 1):35–43.
2. Carande-Kulis VG, Maciosek MV, Briss PA, et al. and the Task Force on Community Preventive Services. Methods for systematic reviews of economic evaluations for the Guide to Community Preventive Services. Am J Prev Med 2000;18(suppl 1):75–91.
3. Zaza S, Sleet DA, Thompson RS, Sosin DM, Bolen JC, Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of child safety seats. Am J Prev Med 2001;21(suppl 4):31–47.
4. Dinh-Zarr TB, Sleet DA, Shults RA, et al. and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase the use of safety belts. Am J Prev Med 2001;21(suppl 4):48–65.
5. Shults RA, Elder RW, Sleet DA, et al. and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to reduce alcohol-impaired driving. Am J Prev Med 2001;21(suppl 4):66–88.
6. The National Committee for Injury Prevention and Control. Injury prevention: meeting the challenge. New York: Oxford University Press, as a supplement to the American Journal of Preventive Medicine, Volume 5, Number 3, 1989.
7. U.S. Department of Health and Human Services. Healthy People 2010, 2nd ed. With understanding and improving health and objectives for improving health. 2 vols. Washington, DC: U.S. Government Printing Office, 2000.
8. National Highway Traffic Safety Administration. Traffic safety facts, 1999: a compilation of motor vehicle crash data from the Fatality Analysis Reporting System and the General Estimates System. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 100.
9. National Highway Traffic Safety Administration. Traffic safety facts 1999: children. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 087.
10. National Highway Traffic Safety Administration. Traffic safety facts 1999: occupant protection. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 090.
11. Zador PL, Krawchuk SA, Voas RB. 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 Stud Alcohol 2000;61:387–95.
12. Zaza S, Wright-de Aguero L, Briss PA, et al. and the Task Force on Community Preventive Services. Data collection instrument and procedure for systematic reviews in the Guide to Community Preventive Services. Am J Prev Med 2000;18(suppl 1):44–74.
13. Gold MR, Siegel JE, Russell LB, Weinstein MC. Cost-effectiveness in health and medicine. New York: Oxford University Press, 1996.
14. Task Force on Community Preventive Services. Recommendations to reduce injuries to motor vehicle occupants: increasing child safety seat use, increasing safety belt use, and reducing alcohol-impaired driving. Am J Prev Med 2001;21(suppl 4):16–22.

Appendix
Economic Efficiency

The *Community Guide* provides information on two kinds of economic efficiency: allocative and productive. In simplified terms, allocative efficiency deals with decisions about what mix of outputs (goods or services) maximizes societal welfare. In the public health arena, these decisions often involve making choices about which program to pursue. For example, assuming fixed resources, a police department may have to make choices between assigning personnel to sobriety checkpoints or to other duties. If new personnel cannot be hired, the costs and benefits of the options must be contrasted. Cost–benefit analysis provides information on the balance between a program's costs and its net societal benefit and can inform these decisions.

Considerations in achieving productive efficiency involve decisions about the best mix of inputs (resources) to use to produce the desired good or service in an efficient manner. Choices must be made because of limited resources. For example, once the decision to implement sobriety checkpoints (the desired service) has been made, different alternatives about how many officers to assign to this work (the best mix of inputs) may need to be considered. The choice may be between using many officers working at multiple checkpoints all over the city and using a few officers in critical locations. Although the first alternative may be highly effective, the second may be less costly. Cost-effectiveness analysis is used to answer the question, "Given a desired goal, what is the cost-effectiveness of the various approaches to reaching that goal?"

Types of Economic Analysis

Cost analysis is the valuation of all the resources consumed by the intervention. Summary measures of a cost analysis include total cost, average cost, and cost per outcome. Total cost is the sum of resource costs of the intervention. Average cost is the total cost of the intervention per person reached by the intervention. Cost per outcome is the total cost of the intervention divided by an intermediate outcome such as additional children using safety seats. Those studies reporting ratios such as program cost per quality-adjusted life year (QALY) were also classified as cost analyses because the numerator included only the program costs and did not include the cost saving from averted illness or injury.

Cost-effectiveness analysis always involves the comparison of two interventions, a proposed intervention "A" and a comparator, intervention "B." The comparator can be an alternative intervention or the status quo (which could be doing nothing). The cost-effectiveness ratio is the net cost of A compared with B, divided by a measure of the effectiveness, such as illness or injury averted. Net cost is the difference of net intervention costs minus cost savings from averted illness or injury. Net program cost is the difference of the costs of A minus the costs of B. Cost savings from averted disease or injury is the cost of illness or injury within intervention A minus the cost of illness or injury within intervention B.

Cost-utility analysis is a variation of cost-effectiveness analysis, in which the health outcome measure is QALYs.

Cost-benefit analysis compares the costs and benefits of two programs in monetary terms. The net benefit ratio is the difference between program cost (of intervention A when compared with intervention B) and benefits (dollar value of the outcome from intervention A when compared with dollar value of the outcome from intervention B).

Reviews of Evidence Regarding Interventions to Increase Use of Child Safety Seats

Stephanie Zaza, MD, MPH, David A. Sleet, PhD, MA, Robert S. Thompson, MD, Daniel M. Sosin, MD, MPH, Julie C. Bolen, PhD, MPH, and the Task Force on Community Preventive Services

Background: In 1998, nearly 600 child occupants of motor vehicles aged younger than 4 years died in motor vehicle crashes. Yet approximately 29% of children aged 4 years and younger do not ride in appropriate child safety seat restraints, which, when correctly installed and used, reduce the need for hospitalization in this age group by 69% and the risk of death by approximately 70% for infants and by 47% to 54% for toddlers (aged 1 to 4 years).

Methods: The systematic review development team reviewed the scientific evidence of effectiveness for five interventions to increase child safety seat use. For each intervention, changes in the use of child safety seats or injury rates were the outcome measures evaluated to determine the success of the intervention. Database searching was concluded in March 1998. More than 3500 citations were screened; of these citations, 72 met the inclusion criteria for the reviews.

Results: The systematic review process identified strong evidence of effectiveness for child safety seat laws and distribution plus education programs. In addition, community-wide information plus enhanced enforcement campaigns and incentive plus education programs had sufficient evidence of effectiveness. Insufficient evidence was identified for education-only programs aimed at parents, young children, healthcare professionals, or law enforcement personnel.

Conclusions: Evidence is available about the effectiveness of four of the five interventions we reviewed. This scientific evidence, along with the accompanying recommendations of the Task Force elsewhere in this supplement, can be a powerful tool for securing the resources and commitment required to implement these strategies.

Medical Subject Headings (MeSH): accidents, traffic; motor vehicles; wounds and injuries; infant equipment; protective devices; community health services; decision making; evidence-based medicine; economics; preventive health services; public health practice (Am J Prev Med 2001;21(4S):31–47)

Introduction

Motor vehicle crash–related injuries kill more children than any other single cause in the United States.[1] In 1998, a total of 1765 child occupants aged 14 years and younger died in motor vehicle crashes; of those, 33% were children younger than 4 years.[1] In 1999, an estimated 272,000 motor vehicle occupants aged 14 and younger were injured in crashes.[2]

For children aged birth to 4 years, child safety seats can be extremely effective. When correctly installed and used, child safety seats reduce the need for hospitalization in this age group by 69%[3] and the risk of death by approximately 70% for infants and by 47% to 54% for toddlers (aged 1 to 4 years).[4] If all child passengers aged 4 years and younger were restrained, each year an additional 162 lives could be saved and 20,000 injuries could be prevented.[5,6]

Approximately 29% of children aged 4 years and younger do not ride in appropriate restraints, placing them at twice the risk of fatal and nonfatal injuries of those riding restrained.[2,7,8] In addition, approximately 85% of children riding in child safety seats are improperly restrained.[9] Seating position imposes an additional risk factor: In passenger vehicles, children aged 12 years and younger are 36% less likely to die in a crash if seated in the back seat.[10]

Some groups of children are more at risk than

From the Division of Prevention Research and Analytic Methods, Epidemiology Program Office (Zaza), Division of Unintentional Injury Prevention (Sleet), Office of the Director (Sosin), National Center for Injury Prevention and Control, and Division of Adult and Community Health, National Center for Chronic Disease Prevention and Health Promotion (Bolen), Centers for Disease Control and Prevention, Atlanta, Georgia; Task Force on Community Preventive Services and The Department of Preventive Care, Group Health Cooperative of Puget Sound (Thompson), Seattle, Washington

Address correspondence and reprint requests to: Stephanie Zaza, MD, MPH, Community Guide Branch, Centers for Disease Control and Prevention, 4770 Buford Highway, MS-K73, Atlanta, GA 30341. E-mail: szaza@cdc.gov.

The names and affiliations of the Task Force members are listed in the front of this supplement and at www.thecommunityguide.org.

0749-3797/01/$–see front matter
PII S0749-3797(01)00377-4

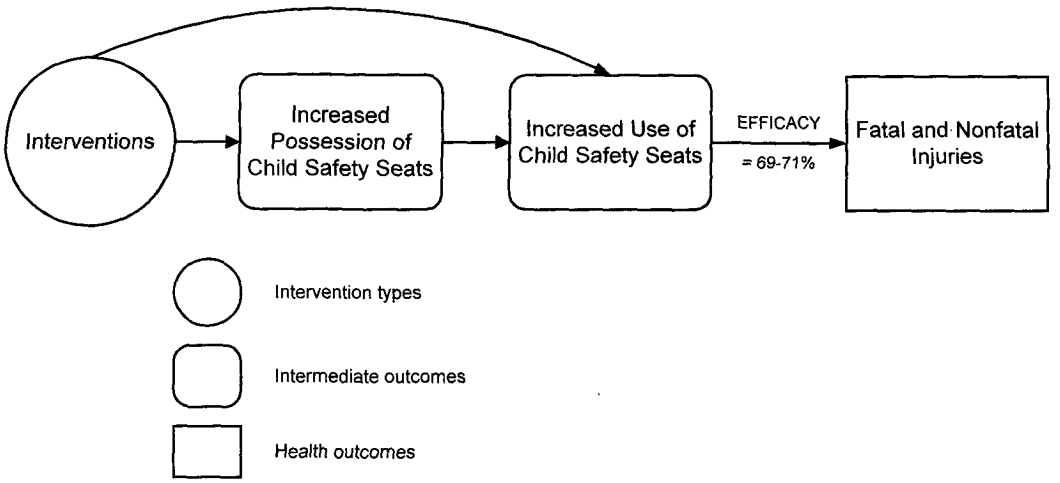


Figure 1. Conceptual approach: interventions to improve child safety seat use.

others. Child safety seat use is lower among rural populations and low-income families.[8,11–13] Lack of access to affordable child safety seats might contribute to lower usage rates among low-income families. However, when they do own a safety seat, 95% of low-income families use it,[5,14–16] suggesting that strategies to increase the availability of free or low-cost child safety seats might be effective.

Given the high burden of fatal and nonfatal injury imposed on children by motor vehicle crashes, the effectiveness of child safety seats in reducing those injuries, and the continued low rate of correct use of child safety seats, we sought to identify which population-based interventions among those currently in use or contemplated by the public health community are most effective. As part of the *Guide to Community Preventive Services* (the *Community Guide*), we conducted systematic literature reviews to determine the effectiveness of population-based interventions to improve the use of child safety seats among children aged birth to 4 years.[17–19]

Methods

The general methods for conducting systematic reviews for the *Community Guide* have been described in detail elsewhere.[17,20,21] The specific methods for conducting reviews of interventions to reduce motor vehicle occupant injuries are also described in detail elsewhere in this issue.[18] This section briefly describes the specific methods to define the conceptual approach, search strategy, intervention selection, and outcome determination for interventions to improve the use of child safety seats.

The general conceptual model used to evaluate the effectiveness of interventions to improve the use of child safety seats is shown in Figure 1. Interventions are designed to increase the possession and correct use of child safety seats. In turn, increased use of child safety seats reduces fatal and nonfatal injuries.

The systematic review development team (see author list and Consultation Team, in Acknowledgments) reviewed the scientific evidence of effectiveness for five interventions: child safety seat laws, community-wide information and enhanced enforcement campaigns, distribution and education programs, incentive and education programs, and education-only programs. For each of these interventions, changes in the use of child safety seats or injury rates were the outcome measures evaluated to determine the success of the intervention. Observed use of child safety seats was the preferred measure and was used when available. Some studies only provided parent-reported use, however. The measure used is specified in the evidence tables, available at the website (www.thecommunityguide.org).

Inclusion criteria for searching the literature are described in the accompanying methods article.[18] These were the first interventions reviewed by the systematic review team, and database searching was concluded in March 1998. More than 3500 citations were screened; approximately 600 studies were retrieved for detailed screening. Of these studies, 72 met the inclusion criteria for the reviews.

Results. Part I. Intervention Effectiveness and Economic Efficiency

Child Safety Seat Laws

Child safety seat laws require children traveling in motor vehicles to be restrained in federally approved safety seats appropriate for the child's age and size. Legislation also specifies the children to whom the law applies by age, height, weight, or a combination of these factors.

Although all states currently have child safety seat laws, a better understanding of the evidence about the effectiveness of these laws will help policymakers in their efforts to strengthen these regulations. In addition, differences in effectiveness based on the variability in state laws might bolster efforts to maintain or

Table 1. Child safety seat laws: descriptive information about included papers

	Number of studies
Papers meeting inclusion criteria	25[22–46]
Papers excluded, limited execution quality	14[22–26,30–32,35,36,38,39,44,46]
Qualifying papers	11[27–29,33,34,37,40–43,45]
Papers reporting on an already-included study	2[33,45]
Actual number of qualifying papers	9[27–29,34,37,40–43]
Study designs	
Time series with concurrent comparison group	5[28,29,34,41,42]
Time series, no concurrent comparison group	2[37,40]
Before–after with concurrent comparison group	1[43]
Nonparametric modeling	1[27]
Outcomes reported	
Fatal injuries	3[27,41,42]
Fatal and nonfatal injuries (or nonfatal injuries only)	5[28,29,34,37,41]
Child safety seat use	3[40,41,43]

strengthen some state laws and to reduce gaps in coverage and protection for some children.

Reviews of evidence

Effectiveness. Our search identified 25 reports on the effectiveness of child safety seat laws.[22–46] Descriptive information about the quality, study design, and outcome measures from these reports is provided in Table 1. Details of the nine independent, qualifying studies[27–29,34,37,40–43] are available at the website (www.thecommunityguide.org).

The nine studies represent evaluations of child safety seat laws in the 50 states (the District of Columbia and Puerto Rico were not studied) that went into effect between 1978 (Tennessee) and 1986 (Alaska). The main characteristics of the laws are:

- *Primary enforcement.* All laws allow for primary enforcement, that is, a driver can be stopped for the sole purpose of being cited and fined for failure to comply with the child safety seat law.
- *Age requirements.* The laws apply to children of various ages (e.g., some apply to children up to the age of 1 year, whereas others apply to children up to the age of 5 years).
- *Seating position.* One study specified that the law applied only to children in the front seat; the remainder of the studies did not specify seating requirements.
- *Penalties.* The various laws allowed for penalties, ranging from an oral warning to a $25 fine.

None of the studies described activities related to the law such as child safety seat loan programs for low-income families, levels of enforcement, or publicity about the law. Summary effects of the systematic review for each of the outcomes of interest, measured from 1 to 12 years after enactment, are presented in Table 2.

Among the studies that evaluated the laws' effects on injury rates, no differences were observed in the effect size on the basis of the age of children who were required to be in safety seats. Too few studies reported enough information about other requirements of the laws (e.g., seating position, penalties, enforcement provisions) to determine whether decreases in injury rates varied because of these factors. Moreover, there were too few studies from each state to allow us to determine whether specific state laws affected injury rates differently.

Applicability. The same body of evidence was used to evaluate the applicability of these laws in different settings and populations. In these studies, all 50 states were represented, and most studies analyzed data from statewide crash reporting files. Therefore, the evidence of effectiveness should be applicable to most child passengers in the United States. However, none of the studies adequately described the study population in terms of age, gender, race, socioeconomic status, region of the state, or other parameters. In addition, none of the studies described the crash reporting systems in adequate detail to determine the extent to

Table 2. Effectiveness of child safety seat laws on various outcomes: summary effects from the body of evidence

Outcome	Number of outcome measures	Median change	Range
Fatal injuries	3[27,41,42]	35% decrease	25.0%–57.3% decrease
Fatal and nonfatal injuries combined	5[28,29,34,37,41]	17.3% decrease	10.5%–35.9% decrease
Child safety seat use	3[40,41,43]	13.0% increase	5.0%–35.0% increase

Table 3. Community-wide information and enhanced enforcement campaigns: descriptive information about included papers

	Number of studies
Papers meeting inclusion criteria	14[47–60]
Papers excluded, limited execution quality	10[47–49,51,55–60]
Qualifying papers	4[50,52–54]
Study designs	
Nonrandomized group trial	1[50]
Time series, no concurrent comparison group	2[53,54]
Before–after, no concurrent comparison group	1[52]
Outcomes reported	
Child safety seat use	4[50,52–54]

which these systems are valid and representative of crashes in their respective state populations. Therefore, differences in effectiveness for various subgroups of the population could not be determined.

Other positive or negative effects. No harms or other beneficial effects of child safety seat laws were identified from the literature.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[18]

Barriers to intervention implementation. Child safety seat laws have been enacted in all 50 states and the District of Columbia. Experts in child passenger safety may encounter political barriers to strengthening the requirements of laws or to implementing or enhancing enforcement of existing laws, especially in the absence of data on how variations in existing laws are related to outcomes.

Conclusion. There is strong evidence of the effectiveness of child safety seat laws to reduce fatal and nonfatal injuries and to increase child safety seat use, according to the rules of evidence used for the *Community Guide.*

Community-Wide Information and Enhanced Enforcement Campaigns

Community-wide information and enhanced enforcement campaigns target information about child safety seats and child automobile safety to an entire community, usually geographic in nature. These campaigns use mass media; information and publicity; safety seat displays in public sites to promote use; and special enforcement strategies such as checkpoints, dedicated law enforcement officials, or alternative penalties (e.g., informational warnings instead of citations). Effective community-wide information and enhanced enforcement campaigns can complement and build on the benefit provided by child safety seat laws.

Reviews of evidence

Effectiveness. Our search identified 14 studies evaluating community-wide information and enhanced enforcement campaigns.[47–60] Descriptive information is provided in Table 3. Details of the four qualifying studies[50,52–54] are available at the website (www.thecommunityguide.org).

The informational techniques used in the campaigns studied included paid advertisements, public service announcements, commentaries by community leaders on local television and radio programs, newspaper articles and editorials, displays of safety seats in public locations, and direct mailings of information about the importance and correct use of child safety seats. In three studies conducted in states with existing child safety seat laws,[50,53,54] enhanced enforcement components included institution of checkpoints, assignment of law enforcement officers dedicated to enforcing the safety seat use law, and alternative penalties instead of citations, for example, informational warnings or vouchers to waive fines if the driver purchases a safety seat. The settings for the four campaigns in this analysis included cities, suburbs, and states. Design and implementation of campaigns involved numerous community organizations and government agencies such as public safety and public health offices, schools, advocacy organizations, and parent groups.

The median difference in safety seat use for these four studies was an increase of 12.3% (range, 3.8% to 20.8% increase) over baseline rates, measured from 1 to 6 months after the program began. The range of effect sizes followed the baseline safety seat use rates among the intervention groups across the four studies. A study with one of the lowest baseline safety seat use rates (13.6%)[53] observed the smallest post-intervention effect (3.8% increase); this study was conducted in Tennessee in 1977 and 1978, early in the development of safety seat use improvement programs and in conjunction with enactment of the first mandatory child safety seat use law in the United States. A study with a higher baseline use rate (20.4%)[52] observed a significant increase in use, to 34.1% (difference, 13.7% increase). Two studies with much higher baseline rates (63.4% and 65.2%, respectively)[50,54] had post-intervention rates of 76.5% and 86.0%, respectively.

Table 4. Child safety seat distribution and education programs: descriptive information about included papers

	Number of studies
Papers meeting inclusion criteria	17[14,15,61–75]
Papers excluded, limited execution quality	7[15,61,65,66,68,70,73]
Qualifying papers	10[14,62–64,67,69,71,72,74,75]
Study designs	
Randomized controlled trials	2[67,72]
Nonrandomized group trials	2[14,69]
Nonrandomized individual trials	2[63,71]
Time series, no concurrent comparison group	2[62,64]
Before–after, no concurrent comparison group	1[74]
Cross-sectional survey	1[75]
Outcomes reported[a]	
All fatal and nonfatal injuries	1[74]
Correct child safety seat use	13[14,62,64,67,69,71,72,74,75]
Possession of child safety seats	7[14,63,75]

[a]Some papers reported more than one independent outcome measure.

Three campaigns were implemented in communities with existing child safety seat laws.[50,53,54] Two of these interventions[50,54] included messages about enhanced enforcement or the threat of enforcement in their mass media components, and they reported increases in child safety seat use of 13.1% and 20.8%, respectively. The intervention that did not use or publicize enhanced enforcement[53] reported a 4.4% increase in safety seat use.

Applicability. The same body of evidence was used to evaluate the applicability of these campaigns in different settings and populations. These four studies were conducted in the United States, Canada, and Australia and involved populations at all socioeconomic levels. Parents of children from birth to 11 years of age were targeted. Two studies[53,54] were conducted statewide and, although the literature did not clarify the targeted populations, they likely included urban, suburban, and rural populations. No study reported the racial or ethnic makeup of the study population.

Other positive or negative effects. Community-wide information and enhanced enforcement campaigns can increase public awareness of child safety seat laws and the dangers of unrestrained travel. Such awareness might be an important predisposing factor for other interventions. Additional benefits of enhanced enforcement might be increased detection and arrest for alcohol-impaired driving and other offenses. No negative effects of community-wide information and enhanced enforcement campaigns were identified for evaluation in this review.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[18]

Barriers to intervention implementation. Barriers to implementing community-wide information and enhanced enforcement campaigns were not identified in the literature but might include the cost of developing and disseminating public information and education material; cost of television and radio announcements; as well as enlisting the support and cooperation of the media, police departments, and other community leaders. Training enforcement personnel on the importance of enforcing child-restraint device laws and the additional burden on court systems resulting from increased law enforcement may also be barriers to implementing these programs.

Conclusion. According to the rules of evidence used for the *Community Guide*, there is sufficient scientific evidence to show that community-wide information and enhanced enforcement campaigns are effective in increasing child safety seat use.

Distribution and Education Programs

Distribution and education programs provide child safety seats to parents through a loan, low-cost rental, or giveaway of an approved safety seat. All programs also include an educational component, the intensity of which varies among programs.

Parents with financial hardship or a poor understanding of the importance of acquiring and using a safety seat might be more likely to use child safety seats if they receive financial assistance and safety education. This review sought to determine the effectiveness of providing low-cost or free safety seats to parents as a means of increasing the use of safety seats.

Reviews of evidence

Effectiveness. Our search identified 17 papers on the effectiveness of distribution and education programs.[14,15,61–75] Descriptive information about these papers is provided in Table 4. Details of the 10 qualifying papers[14,62–64,67,69,71,72,74,75] are available at the website (www.thecommunityguide.org) and are provided as an example in the Appendix.

These 10 programs provided free loaner child safety

Table 5. Effectiveness of child safety seat distribution and education programs on various outcomes: summary effects from the body of evidence

Outcome	Number of outcome measures	Median change	Range[a]
All fatal or nonfatal injuries	1[74]	NA	6.4% decrease
Correct child safety seat use			
Earliest post-intervention assessment (range, birth–2 years)	10[14,62,64,67,69,71,72,74,75]	22.6% increase	4.0%–62.3% increase
Follow-up assessment (range, 1–10 months after first assessment)	3[14,71,72]	6.0% increase	2.1% decrease to 7.0% increase
Possession of child safety seats	5[14,63,71,75]	51.0% increase	16.0%–93.0% increase

[a]When 7 or more outcome measures were available, an interquartile range is presented.
NA, not applicable.

seats, low-cost rentals, or direct giveaways. In addition to providing the safety seats, all programs also gave parents information on proper usage to increase the likelihood that the safety seats would not only be used but also be used correctly. The instructional component varied considerably in terms of content of information, duration and intensity of education, methods used, and the number of methods used. For example, some programs simply provided instruction or written materials (e.g., brochures or pamphlets) on how to use the safety seat, whereas others used various educational and behavioral techniques such as active involvement in discussions, problem solving, safety seat use demonstrations, and rehearsal of skills for correct use of safety seats. Programs were implemented in hospitals, clinics, and homes and through insurance companies and were primarily targeted to parents of infants rather than older children.

Summary effects from the systematic reviews for each outcome of interest are presented in Table 5. Nine of the ten papers reported the effect of these programs on either the correct use or self-reported use of safety seats (Table 5). In addition, one paper[74] evaluated a giveaway program sponsored by an automobile insurance company and observed a significant decline in injury rates among the children of policyholders (Table 5), and four[14,63,71,75] evaluated the programs' effects on possession of safety seats (Table 5). Overall, all studies showed either a reduction in fatal and nonfatal injuries or an increase in child safety seat use, or both.

Applicability. The same body of evidence was used to evaluate the applicability of these programs in different settings and populations.[14,62–64,67,69,71,72,74,75] Distribution programs were effective when implemented in hospitals and clinics, as part of postnatal home visitation, and when provided by an automobile insurance company. In addition, they were effective among urban, suburban, and rural populations and among affluent and poor populations. Studies were conducted in the United States, Canada, Australia, and Sweden with similar results.

Few studies measured baseline use rates before programs were implemented. Therefore, in populations that already have high rates of safety seat use, the level of effectiveness of distribution and education programs might be lower than the results found in this review. In addition, only three of the nine papers reported the effectiveness of such programs for children older than 9 months; the median increase in safety seat use for these three studies was 2.1% (range, 1.1% to 27.0% increase).[64,69,74] Moreover, no papers reported race or ethnicity of the study population.

Other positive or negative effects. Because distribution programs increase the number of seats available, these programs might also result in increases in misuse of safety seats, particularly among new users. None of the identified studies measured misuse of safety seats after distribution programs, and our search did not identify any studies that looked at the likelihood of misuse after this intervention or at the issue of defective used seats.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[18]

Barriers to intervention implementation. Several potential barriers to implementing child safety seat distribution and education programs are described in the literature. Implementing organizations need to consider potential liability; the initial expense for purchasing seats; cleaning and storage of child safety seats; and training of personnel to provide education and to distribute child safety seats. In addition, some child safety seats might be incompatible with certain vehicles.

Conclusion. Strong evidence shows the effectiveness of child safety seat distribution and education programs in improving child safety seat use, according to the rules of evidence used for the *Community Guide.* Additional supportive evidence indicates a decline in injury claims made to an insurance agency and increases in possession of child safety seats.

Incentive and Education Programs

Incentive and education programs reward parents for obtaining and correctly using child safety seats or

Table 6. Child safety seat incentive and education programs: descriptive information about included papers

	Number of studies
Papers meeting inclusion criteria	5[76–80]
Papers excluded, limited execution quality	1[77]
Qualifying papers	4[76,78–80]
Study designs	
Randomized group trial	1[80]
Time series, no concurrent comparison group	3[76,78,79]
Outcomes reported	
Correct child safety seat use	4[76,78–80]

directly reward children for correctly using safety seats. These programs include educational components of varying intensity. If incentives and education programs are effective in increasing use in the short-term, they might also provide the impetus for some parents to continue using safety seats beyond the program.

Reviews of evidence

Effectiveness. Our search identified five reports on the effectiveness of incentive and education programs.[76–80] Descriptive information on these studies is provided in Table 6. Details of the four qualifying papers[76,78–80] are available at the website (www.thecommunityguide.org).

The reward used and the reward distribution method varied in the four studies. Rewards varied from inexpensive trinkets, stickers, or coupons for fast food meals or movies to relatively expensive prizes donated by community merchants. Rewards were contingent on the parent or caregiver's correct use of safety seats at the time of observation. Rewards were distributed constantly over the period of the programs (range of program implementation, 1 to 5 months). In all four programs, rewards were provided to randomly selected eligible participants. In three programs, smaller rewards were also distributed to all eligible participants.[78–80]

All of the programs included an educational component. This component varied considerably in terms of information content, duration and intensity of education, methods used, and the number of methods used. For example, some programs simply provided information about the reward program itself, whereas others provided information about the effectiveness of safety seats or existing laws mandating safety seat use. Some programs provided limited information (e.g., brochures or pamphlets), whereas others used various educational and behavioral techniques such as reinforcement of desired behaviors, educational videos, feedback on correct use, pledge cards, and information to parents about safety seat use. These studies included programs that were implemented in daycare centers and community-wide.

The median overall difference in safety seat use over time for all of the studies was a 9.9% increase (range, 4.8% to 36.0% increase), measured between 1 and 4.5 months after the intervention was stopped. The effectiveness of incentive programs beyond 4.5 months has not been evaluated. Baseline rates were similarly low in all four studies (median, 25.9%; range, 11.37% to 48.0%).

Applicability. The same body of evidence was used to evaluate the applicability of these programs in different settings and populations. Incentive and education programs were implemented in daycare centers and community-wide among a variety of target populations (children and parents of children aged 6 months to 12 years, all socioeconomic groups, urban and rural populations, white and African-American populations) with similar positive effects.

Other positive or negative effects. None of the identified studies measured safety seat misuse as a result of incentive and education programs in the population, and no other studies of the likelihood of misuse with this intervention were identified in the literature.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[18]

Barriers to intervention implementation. Barriers to implementation of incentive and education programs were not identified in the literature but might include the cost of purchasing incentive rewards; maintaining appropriate schedules of reinforcement; training of personnel to provide the education component; and garnering support of schools, daycare centers, and other sites to sponsor incentive and education programs.

Conclusion. Sufficient scientific evidence exists to conclude that incentive and education programs are effective in increasing child safety seat use in the short term (i.e., 1 to 4 months), according to the rules of evidence used for the *Community Guide.*

Education-Only Programs

Education-only programs provide information about the use of child safety seats and relevant skills to parents, children, or professional groups. Giving information to people provides the basic foundation for moving them toward behavior change such as perform-

ing new skills (e.g., routinely restraining children in safety seats) and enacting new policies (e.g., implementing hospital policies to discharge infants only if the parent uses a child safety seat). Provision of information is a central and necessary component of interventions such as community campaigns, distribution programs, and incentive programs.

Distinction between education-only interventions and counseling. In the *Guide to Clinical Preventive Services,* the U.S. Preventive Services Task Force recommends that clinicians counsel parents and children about the use of motor vehicle child safety seats.[81] To complement this recommendation without overlap, we defined education-only programs for this review as any program designed to provide information about child safety seats other than those involving one-on-one counseling of a patient by a primary care clinician. All of the papers reviewed by the U.S. Preventive Services Task Force were considered for our systematic review; several were subsequently excluded because the intervention was limited to one-on-one clinician counseling of patients. The remaining papers were categorized according to the intervention's primary focus (i.e., educational or distribution program); thus, some papers are included in this review of educational programs,[82–84] whereas other papers are included in the review of evidence for distribution programs.[14,71,72]

Reviews of evidence

Effectiveness for different target populations. The effectiveness of education-only programs directed toward parents, children, and professional groups are discussed below.

Education-only programs for parents. Of 11 studies identified,[36,82–91] three had adequate quality of execution and were included in the body of evidence.[85–87] One study reported a randomized clinical trial,[85] one a nonrandomized clinical trial,[87] and one used a before–after design.[86] All three studies evaluated how perinatal education-only programs affected the correct use of child safety seats. None of the studies found that these programs significantly increased the proportion of correct use at the time of discharge from the hospital (median, 2.0% increase; range, 2% decrease to 10.9% increase). Baseline safety seat use rates varied considerably among the three studies (median, 63.9%; range, 8% to 94%).

Education-only programs for children. Of four studies identified,[88,92–94] one had adequate quality of execution and was included in the body of evidence.[92] This study reported a before–after design that evaluated the effect of the educational program on the use of child safety seats. Arneson et al.[92] conducted a 5-day educational program, "Riding with Bucklebear," with children aged 2.5 to 5 years in a preschool setting. Knowledge scores about how to get into a child safety seat and secure it correctly increased significantly among the children from before to after the intervention (t=3.6; p=0.002), but safety seat use did not increase significantly (12% increase; p=0.33; baseline rate not stated).

Education-only programs for professional groups. Two studies were identified,[95,96] both with adequate quality of execution. One study reported a nonrandomized group trial,[95] the other reported a before–after design.[96] The two studies were done in different professional groups and, therefore, evaluated the effect of professional education on different outcomes. Wolf et al.[96] evaluated a program that targeted nursing or obstetrical directors at all Nebraska hospitals that offer newborn delivery services; participants were trained to develop policies and interventions for perinatal women about the use of child safety seats. The study found significant increases from before to after the intervention in the proportion of hospitals with written policies for newborns regarding child safety seats (baseline 25.9%; 62.3% increase; p<0.001), hospitals with short-term loan programs available (baseline 58.8%; 14.1% increase; p<0.05), and hospitals with patient education programs available (baseline 51.2%; 44.1% increase; p<0.0001). Lavelle et al.[95] conducted training for police officers in one community in Colorado and measured rates of enforcement of Colorado's mandatory child safety seat use law compared with rates of enforcement in a comparison community. Officers in the intervention community increased the number of citations issued from 0 to 10 per month to 10 to 20 per month 6 months after the intervention was completed. The number of citations in the comparison community did not change.

Other positive or negative effects. Educational programs for parents might increase their knowledge about child safety seat laws and the effectiveness of safety seats, and improved knowledge might be an important predisposing factor for other interventions. Improper installation of the safety seat in the vehicle, improper harnessing of the child into the safety seat, or improper placement of a rear-facing infant safety seat in a front passenger seat are examples of the safety seat misuse that can occur when parents who have not previously used safety seats receive inadequate education about the devices. No study identified higher rates of misuse between intervention and comparison populations, and no other studies of the likelihood of misuse were identified in the literature.

Educational programs might increase children's knowledge about the benefits of using safety seats or safety belts, and this increased knowledge might be a predisposing factor for other interventions. No study identified increased misuse of child safety seats among people who received the intervention, and none proposed potential harms of educational programs for safety belt use among older children.

Educational programs for professional groups might increase their knowledge about the importance of advocating for safety seat use among children. Their advocacy might, in turn, be a predisposing factor for other interventions. No harms of educational programs for professional groups were proposed in the literature.

Applicability. The body of evidence used to evaluate the applicability of these programs in different settings and populations was the same as that used to evaluate effectiveness. The six studies included in this review were implemented in hospitals, preschools, and work sites. Within these settings, interventions were aimed at specific target populations (parents, children, or professional groups). Educational programs for parents were only directed toward improving safety seat use among infants; none examined the effect of education for parents of older children. Urban and suburban populations of low, middle, and upper socioeconomic status were represented in some of the studies. No studies reported the racial or ethnic makeup of the study populations.

Economic. Evidence about economic effectiveness was not collected for this intervention because effectiveness was not established.

Barriers to intervention implementation. Evidence about barriers was not collected for this intervention because effectiveness was not established.

Conclusion. Available studies provide insufficient evidence to assess the effectiveness of education-only programs in improving knowledge about or use of child safety seats. However, education is a central component of most other effective interventions. Until more and better information becomes available, communities might choose to make decisions about the use of education-only programs on grounds other than evidence of direct effects from available studies.

Results. Part II. Research Issues

Effectiveness

For all five interventions, the team identified key research issues that had not been answered in the systematic review process. These research issues were grouped by the types of evidence sought. The team identified sufficient or strong evidence of effectiveness for four interventions (i.e., child safety seat laws, community-wide information and enhanced enforcement campaigns, distribution programs, and incentive programs). However, several important research issues about the effectiveness of these interventions remain.

1. **Does effectiveness of the intervention change when specific elements are changed? For example,**
   - Does the effectiveness of child safety seat laws vary depending on the requirements of different state laws?
   - Does effectiveness of laws vary depending on the intensity and visibility of regular enforcement in the state?
   - Would the threat of being charged with contributory negligence if an unrestrained child is killed or injured in a motor vehicle crash change the effectiveness of the law?
   - What role does information about laws play in compliance rates?
   - Are distribution programs sponsored by medical care organizations more or less effective than programs implemented by other organizations (e.g., insurance companies or community organizations)?
   - Are low-cost rental programs any more or less effective than free loan programs?
   - Are different incentives needed for different devices (e.g., infant safety seats, child seats, booster seats, safety belts)?
   - What is the relative effectiveness of different incentives (e.g., direct rewards related to restraint use vs chances to win prizes)?
2. **What is the long-term effectiveness of each intervention? For example,**
   - How can the effectiveness of a child safety seat law be maintained over time?
   - Can incentive programs improve long-term use of child safety seats? If so, what kind of reward schedule and distribution method is necessary to maintain positive effects?
3. **How effective are various combinations of these four interventions? For example,**
   - Does enhanced enforcement provide marginal benefit to that provided by legislation?
   - Do hospital discharge policies requiring that newborns be restrained in an approved device increase the effectiveness of distribution programs?

Because the effectiveness of education alone has not been established, basic research questions remain. For example,

- What amount and quality of content are necessary to improve knowledge, attitudes, and behaviors?
- What are appropriate educational contents and methods for delivery to children at various developmental stages?
- What are the appropriate outcomes to measure when educating young children about the use of child safety seats?
- Is education alone effective to:
  —increase parental use of child safety seats?
  —increase children's independent use of child safety seats?
  —increase enforcement of child safety seat laws by law enforcement officials?

—encourage hospital personnel to develop and enforce policies about child safety seat use?

Other Positive and Negative Effects

The studies included in the reviews did not measure other positive and negative effects of the interventions. For all five interventions, research is needed to determine whether each intervention is likely to either increase or reduce misuse of child safety seats. Research is also needed to determine the role of community-wide or individual education in facilitating the effectiveness of other interventions (e.g., legislation, loaner programs).

Applicability

Each of the effective interventions should be applicable in most of the relevant target populations and settings. However, differences in the effectiveness of each intervention for specific subgroups of the population could not be determined. Several questions about the applicability of these interventions in settings and populations other than those studied remain. For example,

- Are these interventions equally effective in all populations within a state (e.g., racial and ethnic minorities, high- and low-income populations, or behavior change-resistant populations)?
- How must the content and methods of the educational components of interventions be altered to work in different populations?
- Are these interventions effective in populations that already have high baseline safety seat use rates?
- Do programs targeted at parents of infants improve the rate at which parents buy or use child safety seats for children older than 1 year?
- Are incentive programs effective in settings other than those studied (e.g., state motor vehicle inspection stations) or when implemented by other organizations (e.g., community groups or local businesses)?

Economic Evaluations

The team did not identify any economic evaluation meeting *Community Guide* standards for these interventions. Thus, basic economic research must still be conducted:

- What is the cost of interventions to increase the use of child safety seats?
- Are interventions to increase the use of child safety seats cost-saving?
- What is the return on investment of interventions to increase child safety seat use?

Discussion

Systematic literature reviews are particularly useful for creating guidelines. The Task Force on Community Preventive Services (the Task Force) has done this by using the evidence from these systematic reviews to make recommendations about the use of the interventions.[97] Systematic reviews are also useful for identifying gaps in our knowledge base. The research questions provided in this article should be used to guide future research, both by government agencies and foundations in allocating research funding and by academic and other research organizations in determining research priorities.

Dissemination of these findings is ongoing through federal and state government agencies, advocacy organizations, and other groups with missions that include reducing child motor vehicle occupant injuries. Implementation advice for these interventions is available from several organizations, including the National Highway Traffic Safety Administration (www.nhtsa.gov), the National Center for Injury Prevention and Control of the Centers for Disease Control and Prevention (www.cdc.gov/ncipc), and the National SAFE KIDS Campaign (www.safekids.org).

An important implementation issue regarding distribution and education programs has arisen since the studies in this review were conducted. Because the integrity of child safety seats can be compromised in a crash, seats returned to a distribution and education program should not be lent to others because there can be no guarantee that they were not involved in a crash. Therefore, when implementing child safety seat distribution and education programs, only new, unused seats should be provided to all recipients.

These interventions are aimed at children aged birth to 4 years and their parents. All 50 states require children in this age group to be properly restrained while riding in motor vehicles. An accompanying article in this supplement[98] addresses interventions to improve the use of safety belts among teenagers and adults. A clear gap in these two sets of reviews and in the Task Force's recommendations is for children who are too old or too large to sit in child safety seats but who are too small to wear safety belts without the use of booster seats (generally children aged 4 to 8 years).[99] The literature base regarding the efficacy of booster seats, and particularly for population-based interventions to improve their use, is still emerging. Future updates of these reviews and recommendations should address this vulnerable population.

Systematic reviews are limited to the information published in the existing studies. In the present reviews, for example, no studies discriminated between correct and incorrect use of child safety seats. Although some studies evaluated correct use only, they neither estimated incorrect use nor discussed how to correct

mistakes in child safety seat installation or child restraint. Because estimates of misuse of child safety seats are so high, it is imperative to continue research on how to reduce misuse of child safety seats.[100]

Finally, these reviews did not examine positioning of children within the car. Recent evidence has clearly shown a relationship between placement of rearward-facing infant safety seats in the passenger seat of a car with an activated airbag and increased risk of death of the infant if the airbag is deployed.[101] None of the studies included in the reviews examined the effect of the interventions on placement of the child safety seat in the rear seat of the car. This problem is due largely to the abundance of studies that predated either the widespread installation of airbags or the recognition of the danger of airbags to infants and children.[7,102]

Although numerous questions remain, evidence is available about the effectiveness of four of the five strategies we reviewed. This scientific evidence, along with the accompanying recommendations of the Task Force,[97] can be a powerful tool for securing the resources and commitment required to implement these strategies.

We thank the following individuals for their contributions to this review: Erin Finley and Krista Hopkins, *Research Assistants*; Randy Elder, *Service Fellow*; Vilma G. Carande-Kulis and Mary Olufemi Alao, *Economics Team*; Sandra Bonzo and Joanna Taliano, Research Librarians; Kate W. Harris, Editor; our **Consultation Team**—J. C. Bolen, PhD, MPH, National Center for Chronic Disease Prevention and Health Promotion, CDC, Atlanta, GA; R. D. Brewer, MD, MSPH, Nebraska Department of Health, Lincoln; S. D. Bryn, MPH, Health Resources Services Administration, Rockville, MD; F. M. Council, PhD, University of North Carolina, Chapel Hill; R. W. Denniston, MA, Substance Abuse and Mental Health Services Administration, Rockville, MD; A. C. Gielen, ScD, ScM, Johns Hopkins University, Baltimore, MD; S. Gorcowski, MA, National Highway Traffic Safety Administration, Washington, DC; C. A. Hurley, BA, National Safety Council, Washington, DC; B. H. Jones, MD, MPH, National Center for Injury Prevention and Control, CDC, Atlanta, GA; T. A. Karlson, PhD, University of Wisconsin, Madison; M. R. Kinde, MPH, Minnesota Department of Health, Minneapolis; D. W. Lawrence, MPH, RN, San Diego State University, CA; S. E. Martin, PhD, National Institute for Alcohol Abuse and Alcoholism, Rockville, MD; J. A. McKnight, PhD, National Public Service Research Institute, Landover, MD; A. D. Mickalide, PhD, CHES, National SAFE KIDS Campaign, Washington, DC; J. L. Nichols, PhD, National Highway Traffic Safety Administration, Washington, DC; L. F. Novick, MD, MPH, Onandaga County Department of Health, Syracuse, NY; F. P. Rivara, MD, MPH, University of Washington, Seattle; C. W. Runyan, PhD, MPH, University of North Carolina, Chapel Hill; R. J. Smith, MS, Health Resources and Services Administration, Rockville, MD; P. F. Waller, PhD, University of Michigan, Ann Arbor; A. F. Williams, PhD, Insurance Institute for Highway Safety, Arlington, VA; and our **Abstraction Team**—A. Dellinger, PhD, National Center for Injury Prevention and Control, CDC, Atlanta, GA; I. Fischer, MPH, St. Louis Children's Hospital, St. Louis, MO; D. W. Lawrence, MPH, RN, San Diego State University, CA; J. Oh, MD, MPH, Harrisburg, PA; K. Quinlan, MD, MPH, University of Chicago, Pritzker School of Medicine, Chicago, IL; L. Rhodes, MPA, MPH, National Center for Chronic Disease Prevention and Health Promotion, CDC, Atlanta, GA; R. A. Shults, PhD, MPH, National Center for Injury Prevention and Control, CDC, Atlanta, GA; D. Sudakin, MD, MPH, Oregon State University, Corvallis.

References

1. Centers for Disease Control and Prevention, National Center for Health Statistics. 1998 mortality data. Hyattsville, MD: National Center for Health Statistics, 2000.
2. National Highway Traffic Safety Administration. Traffic safety facts 1999: children. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 087.
3. National Highway Traffic Safety Administration. Buckle Up America: the presidential initiative for increasing seat belt use nationwide. First report to Congress. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1998. DOT HS 808 667.
4. National Highway Traffic Safety Administration. Research note: revised estimates of child restraint effectiveness. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1996. Report No 96.855.
5. Children's Safety Network. Childhood injury: cost & prevention facts. Child safety seats: how large are the benefits and who should pay? Landover, MD: Children's Safety Network: Economics and Insurance Resource Center, 1997.
6. National Highway Traffic Safety Administration. Traffic safety facts, 1999: a compilation of motor vehicle crash data from the Fatality Analysis Reporting System and the General Estimates System. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 100.
7. Centers for Disease Control and Prevention. Air-bag associated fatal injuries to infants and children riding in front passenger seats–United States. MMWR 1995;44(45):845–7.
8. Johnston C, Rivara FP, Soderberg R. Children in car crashes: analysis of data for injury and use of restraints. Pediatrics 1994;93:960–5.
9. Taft CH, Mickalide AD, Taft AR. Child passengers at risk in America: a national study of car seat misuse. Washington, DC: National SAFE KIDS Campaign, 1999.
10. Braver ER, Whitfield RA, Ferguson SA. Risk of death among child passengers in front and rear seating positions. Warrendale, PA: Society of Automotive Engineers, 1997. SAE Technical Paper No 973298.
11. Hazinski MF, Eddy VA, Morris JA Jr. Children's traffic safety program: influence of early elementary school safety education on family seat belt use. J Trauma 1995;39:1063–8.
12. National Highway Traffic Safety Administration. National Occupant Protection Use Survey: controlled intersection study. Research note. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, 1995.
13. National Highway Traffic Safety Administration. Rural and urban crashes: a comparative analysis. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1996. DOT HS 808 450.
14. Robitaille Y, Legault J, Abbey H, Pless IB. Evaluation of an infant car seat program in a low-income community. Am J Dis Child 1990;144:74–8.
15. Louis B, Lewis M. Increasing car seat use for toddlers from inner-city families. Am J Public Health 1997;87:1044–5.
16. National Highway Traffic Safety Administration. Strategies to increase the use of child safety seats by low-income families: a report to the Committees on Appropriations, U.S. House of Representatives, U.S. Senate. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1991.
17. Briss PA, Zaza S, Pappaioanou M, et al. and the Task Force on Community Preventive Services. Developing an evidence-based Guide to Community Preventive Services—methods. Am J Prev Med 2000;18(suppl 1):35–43.
18. Zaza S, Carande-Kulis VG, Sleet DA, et al. and the Task Force on Community Preventive Services. Methods for conducting systematic reviews of the evidence of effectiveness and economic efficiency of interventions to

reduce injuries to motor vehicle occupants. Am J Prev Med 2001;21(suppl 4):23–30.
19. Truman BI, Smith-Akin CK, Hinman AR, et al. and the Task Force on Community Preventive Services. Developing the Guide to Community Preventive Services—overview and rationale. Am J Prev Med 2000;18(suppl 1):18–26.
20. Carande-Kulis VG, Maciosek MV, Briss PA, et al. and the Task Force on Community Preventive Services. Methods for systematic reviews of economic evaluations for the Guide to Community Preventive Services. Am J Prev Med 2000;18(suppl 1):75–91.
21. Zaza S, Wright-de Aguero L, Briss PA, et al. and the Task Force on Community Preventive Services. Data collection instrument and procedure for systematic reviews in the Guide to Community Preventive Services. Am J Prev Med 2000;18(suppl 1):44–74.
22. Ain KB, Barrall DT, Perez RG, Ward HA. Patterns of automotive safety restraint use in Rhode Island: impact of the child passenger restraint law. R I Med J 1981;64:515–9.
23. O'Brien JF. Child safety restraint study: a study of the effects of child safety restraint legislation on the incidence and severity of motor vehicle accident injuries to children six years of age and younger (based on 1980–1982 and 1984–1985 accidents). Albany, NY: New York State Department of Motor Vehicles, 1986. PB87-183554.
24. Agent KR. Usage rates and effectiveness of safety belts and child safety seats in Kentucky, 1988. Lexington, KY: Kentucky Transportation Center, College of Engineering, University of Kentucky, 1988. KTC-88-6.
25. Agran PF, Dunkle DE, Winn DG. The effects of safety seat legislation on pediatric trauma. Washington, DC: U.S. Department of Transportation, Office of University Research, 1986. DOT/OST/P-34/86-044.
26. Agran PF, Dunkle DE, Winn DG. Effects of legislation on motor vehicle injuries to children. Am J Dis Child 1987;141:959–64.
27. Evans WN, Graham JD. An estimate of the lifesaving benefit of child restraint use legislation. J Health Econ 1990;9:121–42.
28. Guerin D, MacKinnon DP. An assessment of the California child passenger restraint requirement. Am J Public Health 1985;75:142–4.
29. Rock SM. Impact of the Illinois child passenger protection act: a retrospective look. Accid Anal Prev 1996;28:487–92.
30. Hall WL. The North Carolina child passenger protection law: implementation and evaluation, July 1982–June 1985. Chapel Hill, NC: University of North Carolina Highway Safety Research Center, 1985. 85-04-LE-304-01.
31. Montague RB. The introduction of child safety seat legislation in Virginia: types and levels of community response and effects on automobile accident statistics. Washington, DC: U.S. Department of Transportation, Office of University Research, 1984. DOT/OST/P-34/85/024.
32. Muller A. Is the Oklahoma child restraint law effective? (letter). Am J Public Health 1986;76:1251–2.
33. Wagenaar AC. Mandatory child restraint laws: impact on childhood injuries due to traffic crashes. J Safety Res 1985;16:9–21.
34. Wagenaar AC, Maybee RG, Sullivan KP. Michigan's compulsory restraint use policies: effects on injuries and deaths. Ann Arbor: University of Michigan Transportation Research Institute, 1987. UMTRI 87-10.
35. Williams AF, Wells JK. The Tennessee child restraint law in its third year. Am J Public Health 1980;71:163–5.
36. Alvarez J, Jason LA. The effectiveness of legislation, education, and loaners for child safety in automobiles. J Community Psychol 1993;21:280–4.
37. Margolis LH, Wagenaar AC, Liu W. The effects of a mandatory child restraint law on injuries requiring hospitalization. Am J Dis Child 1988; 142:1099–103.
38. Partyka SC. Effect of child occupant protection laws on fatalities. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1989. DOT HS 807 453.
39. Rood DH, Kraichy PP. Evaluation of New York state's mandatory occupant restraint law. Volume 3: observational surveys of safety restraint use by children in New York State. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1986. DOT HS 806 972.
40. Seekins T, Fawcett SB, Cohen SH, et al. Experimental evaluation of public policy: the case of state legislation for child passenger safety. J Appl Behav Anal 1988;21:233–43.
41. Sewell CM, Hull HF, Fenner J, Graff H, Pine J. Child restraint law effects on motor vehicle accident fatalities and injuries: the New Mexico experience. Pediatrics 1986;78:1079–84.
42. Wagenaar AC, Webster DW, Maybee RG. Effects of child restraint laws on traffic fatalities in eleven states. J Trauma 1987;27:726–32.
43. Williams AF, Wells JK. Evaluation of the Rhode Island child restraint law. Am J Public Health 1981;71:742–3.
44. Cunningham JL, Hughes EC, Philpot JW, Pentz CA. Parents' knowledge, attitudes and behavior about child passenger safety. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1981. DOT HS 805 947.
45. Wagenaar AC, Webster DW. Preventing injuries to children through compulsory automobile safety seat use. Pediatrics 1986;78:662–72.
46. Williams AF. Evaluation of the Tennessee child restraint law. Am J Public Health 1979;69:455–8.
47. Gielen AC, Radius S. Project KISS (Kids in Safety Seats): educational approaches & evaluation measures. Health Educ 1984;15:43–7.
48. National Highway Traffic Safety Administration. Evaluation of child safety seat enforcement strategies. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1989. DOT HS 807 479.
49. Bowler MA, Torpey S. Community road safety program (Latrobe Valley). First 18 months of operation. Victoria, Australia: Road Traffic Authority, 1988. GR/88/3.
50. Decina LE, Temple MG, Dorer HS. Increasing child safety-seat use and proper use among toddlers. Evaluation of an enforcement and education program. Accid Anal Prev 1994;26:667–73.
51. McCooey EB, Feun L. TLC—tender loving care for tender living cargo: an innovative approach to child passenger safety in a local health department. Health Educ 1984;15:48–51.
52. Pless IB, Stulginskas J, Zvagulis I. Observed effects of media campaigns on restraint use. Can J Public Health 1986;77:28–32.
53. Heathington KW, Philpot JW, Perry RL. Impact of legislation and public information and education on child passenger safety. Transportation Res Rec 1982;62–70.
54. Lane JM, Milne PW, Wood HT. Evaluation of a successful rear seat belt publicity campaign. The 12th ARRB Conference, Hobart, Tasmania, August 27–31, 1984. pp. 13–21.
55. Cox RG, Fleming D. Selective enforcement campaign to increase the use of restraints by children in motor vehicles. Sydney, Australia: National Roads and Motorists' Association, 1981. UMTRI 47823.
56. Hall WL, Orr BT, Suttles DT, et al. Progress report on increasing child restraint usage through local education and distribution programs. Chapel Hill, NC: University of North Carolina Highway Safety Research Center, 1983. UNC/HSRC-83-10-2.
57. Boughton CJ, Johnston IR. The effects of radio and press publicity on the safe carriage of children in cars. Warrendale, PA: Society of Automotive Engineers, Inc., 1979. 790075.
58. Land G, Romeis JC, Gillespie KN, Denny S. Missouri's Take a Seat, Please! and program evaluation. J Public Health Manag Pract 1997;3:52–9.
59. Geddis DC. How children travel in cars in New Zealand. N Z Med J 1982;95:740–2.
60. Wheeler YCH. Restraint use attitudes and knowledge prior to and following the 1993 rear seat child restraint use campaign in NSW amongst three non-English speaking background communities. New South Wales, Australia: Roads and Traffic Authority (NSW), Road Safety Bureau, 1994. Research Note RN 15/94.
61. Berger LR, Saunders S, Armitage K, Schauer L. Promoting the use of car safety devices for infants: an intensive health education approach. Pediatrics 1984;74:16–9.
62. Colletti RB. Longitudinal evaluation of a statewide network of hospital programs to improve child passenger safety. Pediatrics 1986;77:523–9.
63. Culler CJ, Cunningham JL. Compliance with the child passenger protection law: effects of a loaner program for low-income mothers. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1980. DOT HS 805 801.
64. Geddis DC, Appleton IC. Establishment and evaluation of a pilot child car seat rental scheme in New Zealand. Pediatrics 1986;77:167–72.
65. Hletko PJ, Hletko J, Shelness A, Nyberg J. The effect of a toddler/child restraint device rental program on observed correct use. 27th Annual Conference Proceedings, American Association for Automotive Medicine, October 3–6, 1983. pp. 115–125.
66. Hletko PJ, Hletko J, Shelness A, Nyberg J. The effect of an in-hospital maternity education program on observed correct crash restraint device use. 26th Annual Proceedings, American Association for Automotive Medicine, October 4–6, 1982. pp. 219–32.
67. Hletko PJ, Robin SS, Hletko JD, Stone M. Infant safety seat use: reaching the hard to reach. Am J Dis Child 1987;141:1301–4.
68. Jarmark S, Ljungblom BA, Turbell T. Infant carriers—a trial in two counties. Linkoeping, Sweden: National Swedish Road & Traffic Research Institute, 1988. 316A HS-040 518.VTI Rapport.

69. Lindqvist KS. Does the use of child safety seats increase as the result of loan schemes? Accid Anal Prev 1993;25:421–9.
70. Nichol KP, Cooney CE. The impact of a hospital-based educational loaner infant car seat program on infant car seat usage in a community. Travel Med Int 1984;2:155–8.
71. Reisinger KS, Williams AF. Evaluation of programs designed to increase the protection of infants in cars. Pediatrics 1978;62:280–7.
72. Christophersen ER, Sullivan MA. Increasing the protection of newborn infants in cars. Pediatrics 1982;70:21–5.
73. Moyes CD, Tustin RJ, McLean JF, Turner GR. Changing patterns in child restraint use (letter). N Z Med J 1984;97:242.
74. Saalberg JH, Morrison AJ. Restraint use and injury experience. In: Evaluation of the League General Insurance Company child safety seat distribution program; DOT HS 806 253. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1982:22–47.
75. Saalberg JH, Morrison AJ. Household survey. In: Evaluation of the League General Insurance Company child safety seat distribution program; DOT HS 806 253. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1982:63–120.
76. Foss RD. Evaluation of a community-wide incentive program to promote safety restraint use. Am J Public Health 1989;79:304–6.
77. Liberato CP, Eriacho B, Schmiesing J, Krump M. SafeSmart safety seat intervention project: a successful program for the medically-indigent. Patient Educ Couns 1989;13:161–70.
78. Roberts MC, Turner DS. Rewarding parents for their children's use of safety seats. J Pediatr Psychol 1986;11:25–36.
79. Roberts MC, Layfield DA. Promoting child passenger safety: a comparison of two positive methods. J Pediatr Psychol 1987;12:257–71.
80. Stuy M, Green M, Doll J. Child care centers: a community resource for injury prevention. J Dev Behav Pediatr 1993;14:224–9.
81. U.S. Preventive Services Task Force. Guide to Clinical Preventive Services: report of the U.S. Preventive Services Task Force. 2nd ed. Baltimore: Williams & Wilkins, 1996.
82. Allen DB, Bergman AB. Social learning approaches to health education: utilization of infant auto restraint devices. Pediatrics 1976;58:323–8.
83. Greenberg LW, Coleman AB. A prenatal and postpartum safety education program: influence on parental use of infant car restraints. J Dev Behav Pediatr 1982;3:32–4.
84. Miller JR, Pless IB. Child automobile restraints: evaluation of health education. Pediatrics 1977;59:907–11.
85. Christophersen ER, Sosland-Edelman D, LeClaire S. Evaluation of two comprehensive infant car seat loaner programs with 1-year follow-up. Pediatrics 1985;76:36–42.
86. Goebel JB, Copps TJ, Sulayman RF. Infant car seat usage. Effectiveness of a postpartum educational program. JOGN Nurs 1984;13:33–6.
87. Tietge NS, Bender SJ, Scutchfield FD. Influence of teaching techniques on infant car seat use. Patient Educ Couns 1987;9:167–75.
88. Bowman JA, Sanson-Fisher RW, Webb GR. Interventions in preschools to increase the use of safety restraints by preschool children. Pediatrics 1987;79:103–9.
89. Chang A, Hearey CD, Gallagher KD, English P, Chang PC. Promoting child passenger safety in children served by a health maintenance organization. Patient Educ Couns 1989;13:297–307.
90. Geddis DC, Pettengell R. Parent education: Its effect on the way children are transported in cars. N Z Med J 1982;95:314–6.
91. Goodson JG, Buller C, Goodson WH III. Prenatal child safety education. Obstet Gynecol 1985;65:312–5.
92. Arneson SW, Triplett JL. Riding with Bucklebear: an automobile safety program for preschoolers. J Pediatr Nurs 1990;5:115–22.
93. Chang A, Dillman AS, Leonard E, English P. Teaching car passenger safety to preschool children. Pediatrics 1985;76:425–8.
94. Williams AF, Wells JK, Ferguson SA. Development and evaluation of programs to increase proper child restraint use. J Safety Res 1997;28:69–73.
95. Lavelle JM, Hovell MF, West MP, Wahlgren DR. Promoting law-enforcement for child protection: a community analysis. J Appl Behav Anal 1992;25:885–92.
96. Wolf D, Tomek DJ, Stacy RD, Corbin DE, Greer DL. Promoting hospital discharge of infants in safety seats. J Community Health 1995;20:345–57.
97. Task Force on Community Preventive Services. Recommendations to reduce injuries to motor vehicle occupants: increasing child safety seat use, increasing safety belt use, and reducing alcohol-impaired driving. Am J Prev Med 2001;21(suppl 4):16–22.
98. Dinh-Zarr TB, Sleet DA, Shults RA, et al. and the Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of safety belts. Am J Prev Med 2001;21(suppl 4):48–65.
99. Centers for Disease Control and Prevention. Motor-vehicle occupant fatalities and restraint use among children aged 4–8 years. United States, 1994–1998. MMWR 2000;49(07):135–7.
100. Centers for Disease Control and Prevention. Improper use of child safety seats—Kentucky, 1996. MMWR 1998;47(26):541–4.
101. National Highway Traffic Safety Administration. Children and air bags. 2001. Available at: www.nhtsa.dot.gov/people/injury/airbags/Airbags.html. Accessed March 9, 2001.
102. Centers for Disease Control and Prevention. Notice to readers. Approval of installation of air bag on-off switches for certain motor-vehicle owners. MMWR 1997;46(46):1098–9.

Appendix: Studies Measuring the Effectiveness of Child Safety Seat Distribution Programs

Author & year (study period) Design suitability: design Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Results: Effect measure	Reported baseline	Reported effect	Value used in summary[a]	Follow-up time
Studies measuring the effect on injury rates							
Saalberg, Chapter 5, 1982 (1977-81)[1] Least: Before-after Good Insurance company	Location: Michigan, USA Components: Child safety seat giveaway Comparison: Pre-program period and families not issued a restraint by the company	Parents of 0–4-year-old children N = 7140 seats distributed to 5776 households	Injuries (record review)	16.3%	10%, p<0.05	-6.3%	0–2 years
Studies measuring the effect on use of safety seats							
Robitaille 1990 (1981-82)[2] Greatest: Non-randomized group trial Good Clinic, home visits	Location: Montreal, Canada Components: Loan program, classroom instruction, instructional films, community safety belt/safety seat promotional programs Comparison: Community safety belt/safety seat promotional programs	Mother/infant pairs N = 635 community-wide observations	Self-reported use 3 months 13 month follow-up	Intervention vs comparison 40.8% vs 21.6% [11.5, 26.7] 66.3% vs 54.3%		 +18.2% +2.1%	 3 months 10 months
Christopherson 1982 (1981)[3] Greatest: Randomized clinical trial Fair Hospital	Location: Kansas City, Kansas, USA Components: Loan program and demonstration of safety seat use Comparison: Usual discharge instructions (not described)	Mother/infant pairs N = 15 (intervention) N = 15 (comparison)	Correct use (observed) Discharge 4-6 week follow-up	Intervention vs comparison 67% vs 0% (p<0.001) 29% vs 23% (p>0.05)		 +67% +6%	 Discharge from hospital 4–6 weeks
Colletti 1986 (1979-84)[4] Moderate: Time series Fair Hospitals	Location: Vermont, USA Components: Rental program pamphlets, demonstration, skill rehearsal Comparison: Pre-program period	Mother/infant pairs N = 1846	Correct use (observed)	1979 <21%	1984 82%	 +61%	 Discharge from hospital
Geddis 1986 (1981-84)[5] Moderate: Time series Fair Hospital	Location: Dunedin, New Zealand Components: Rental program, pamphlets, individual education, letters/pamphlets mailed to parents not visited in hospital, monthly public safety campaigns (not described) Comparison: Pre-program period	Observed infants or children in motor vehicles 0-6 months N = 582 6-18 months N = 471	Correct use (observed) 0-6 months old 6-18 months old	1981 0% 61%	1984 +66% +27%	 +66% +27%	 0-18 months 0-18 months

Appendix Continued

Author & year (study period) Design suitability: design Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Effect measure	Results Reported baseline	Reported effect	Value used in summary[a]	Follow-up time
Hletko, 1987 (1985)[6] Greatest: Randomized clinical trial Fair Hospital	Location: Kalamazoo, Michigan, USA Components: Rental program, interactive video instruction, quizzes, demonstration, reinforcing materials Comparison 1: Individual education, filmstrip, pamphlet Comparison 2: No intervention, community members	Mother/infant pairs N=295 (intervention) N=300 (comparison 1) N=358 (comparison 2)	Correct use (observed)	Intervention vs comparison 1 64.6% vs 63.9%, $X^2 = 1.06$, p>0.05 Intervention plus comparison 1 vs comparison 2 64.3% vs 53.1%, p<0.05		+0.7% Not used	4 months
Lindqvist, 1993 (1984-85)[7] Greatest: Non-randomized group trial Fair Hospital	Location: Ostergotland, Sweden Components: Loan program, demonstration of use, videotape ("Safety from the Beginning") Comparison: Usual care (not described)	Observed infants in motor vehicles N = 764 (intervention) N = 397 (comparison)	Self-reported use 0-9 months old 9-12 month follow-up	Intervention vs comparison 96.2% vs 49.4% 98.7% vs 97.6%		+46.8% +1.1%	9 months 6 months
Reisinger, 1978 (1976-77)[8] Greatest: Non-randomized clinical trial Fair Hospital	Location: Pittsburgh, Pennsylvania, USA Group 1: Safety seats made easily available for purchase, literature, nurses supportive Group 2: Literature, displays, safety seats made easily available for purchase; demonstration and discussion if purchased Group 3: Literature plus offer of free safety seat; demonstration if purchased; seats NOT readily available for purchase Comparison (Group 4): Safety seats available for purchase in hospital shop	Mother/infant pairs Group 1: N = 271 Group 2: N = 295 Group 3: N = 265 Comparison (Group 4): N = 272	Correct use (observed) at: Discharge from hospital 2-4 month follow-up	Group 1 vs 4 Group 2 vs 4 Group 3 vs 4 Group 1 vs 4 Group 2 vs 4 Group 3 vs 4	8% vs 6% 8% vs 6% 11% vs 6% 22% vs 21% 20% vs 21% 28% vs 21%	Not used Not used +5% Not used Not used +7%	Immediate 2–4 months
Saalberg, Chapter 5, 1982 (1977-81)[1] Least: Before-after Good Insurance company	Location: Michigan, USA Components: Child safety seat giveaway Comparison: Pre-program period and families not issued a restraint by the company	Parents of 0–4-year-old children N = 7140 seats distributed to 5776 households	Self-reported use	Intervention vs comparison 56.6% vs 16.7%, p<0.01		+39.9%	0–2 years

Appendix Continued

Author & year (study period) Design suitability: design Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Effect measure	Results: Reported Baseline	Results: Reported effect	Value used in summary[a]	Follow-up time
Saalberg, Chapter 8, 1982 (1979-81)[9] Least: Cross-sectional Fair Insurance company	Location: Michigan, USA Components: Safety seat giveaway Comparison: Families not issued a safety seat by the company	*Parents of 0–4-year-old children* N = 800 households	Self-reported use	*Families provided a restraint vs families not provided a restraint*	23% vs 22%	+1%	0–2 years
Studies measuring the effect on possession/acquisition of safety seats							
Robitaille 1990 (1981-82)[2] Greatest: Non-randomized group trial Good Clinic, home visits	Location: Montreal, Canada Components: Loan program, classroom instruction, instructional films, community safety belt/safety seat promotional programs Comparison: Community safety belt/safety seat promotional programs	Mother/infant pairs N = 635 community-wide observations	Self-reported possession 3 months	Intervention vs comparison	61% vs 39.7% [10.6, 27.5]	+21.3%	3 months
Culler, 1980 (1979)[10] Greatest: Non-randomized *clinical trial* Fair Hospital	Location: Chattanooga, Tennessee, USA Group 1: Offered a low-cost rental Group 2: Offered a free loaner Comparison: Encouraged to use own resources to acquire a safety seat	Mother/infant pairs N = 35 (Group 1) N = 40 (Group 2) N = 44 (Comparison)	Self-reported acquisition	Group 1: 51% Group 2: 83% Comparison: 0% X^2 =64.32, p<0.0001		51% 83%	3-8 weeks 3-8 weeks
Reisinger, 1978 (1976-77)[8] Greatest: Non-randomized clinical trial Fair Hospital	Location: Pittsburgh, Pennsylvania, USA Group 1: Safety seats made easily available for purchase, literature, nurses supportive Group 2: Literature, displays, safety seats made easily available for purchase; demonstration and discussion if purchased Group 3: Literature plus offer of free safety seat; demonstration if purchased; seats NOT readily available for purchase Comparison (Group 4): Safety seats available for purchase in hospital shop	Mother/infant pairs Group 1: N = 271 Group 2: N = 295 Group 3: N = 265 Comparison (Group 4): N = 272	In-hospital acquisition	Group 1 vs 4 Group 2 vs 4 Group 3 vs 4	6% vs 1% 11% vs 1% 94% vs 1%	Not used Not used +93%	Immediate

Appendix Continued

Author & year (study period) Design suitability: design Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Results				
			Effect measure	Reported Baseline	Reported effect	Value used in summary[a]	Follow-up time
Saalberg, Chapter 8, 1982 (1979-81)[9] Least: Cross-sectional Fair Insurance company	Location: Michigan, USA Components: Safety seat giveaway Comparison: Families not issued a safety seat by the company	Parents of 0–4-year-old children N = 800 households	Self-reported possession	Families provided a restraint vs families not provided a restraint: 78% vs 62%		+16%	0–2 years

[a] This is the value used to summarize the evidence and to develop the recommendation. In some cases, this column reflects values calculated because the effects reported by the authors were not consistent with effect measures used in other studies.

References

1. Saalberg JH, Morrison AJ. Evaluation of the League General Insurance Company child safety seat distribution program. 1982. NTIS Report ID Final rpt.HS-806 253; Chapter 5, pp. 22-47.
2. Robitaille Y, Legault J, Abbey H, Pless IB. Evaluation of an infant car seat program in a low-income community. Am J Dis Child 1990;144:74-8.
3. Christophersen ER, Sullivan MA. Increasing the protection of newborn infants in cars. Pediatrics 1982;70:21-5.
4. Colletti RB. Longitudinal evaluation of a statewide network of hospital programs to improve child passenger safety. Pediatrics 1986;77:523-9.
5. Geddis DC, Appleton IC. Establishment and evaluation of a pilot child car seat rental scheme in New Zealand. Pediatrics 1986;77:167-72.
6. Hletko PJ, Robin SS, Hletko JD, Stone M. Infant safety seat use: reaching the hard to reach. Am J Dis Child 1987;141:1301-4.
7. Lindqvist KS. Does the use of child safety seats increase as the result of loan schemes? Accid Anal Prev 1993;25:421-9.
8. Reisinger KS, Williams AF. Evaluation of programs designed to increase the protection of infants in cars. Pediatrics 1978;62:280-7.
9. Saalberg JH, Morrison AJ. Evaluation of the League General Insurance Company child safety seat distribution program. 1982. NTIS Report ID Final rpt.HS-806 253; Chapter 8, pp. 63-120.
10. Culler CJ, Cunningham JL. Compliance with the child passenger protection law: effects of a loaner program for low-income mothers. 1980. NTIS Report ID:HS-805 801.

Reviews of Evidence Regarding Interventions to Increase the Use of Safety Belts

Tho Bella Dinh-Zarr, PhD, MPH, David A. Sleet, PhD, MA, Ruth A. Shults, PhD, MPH, Stephanie Zaza, MD, MPH, Randy W. Elder, MEd, James L. Nichols, PhD, Robert S. Thompson, MD, Daniel M. Sosin, MD, MPH, and the Task Force on Community Preventive Services

Background: The use of safety belts is the single most effective means of reducing fatal and nonfatal injuries in motor vehicle crashes. If all motor vehicle occupants consistently wore safety belts, an estimated 9553 deaths would have been prevented in 1999 alone.

Methods: The *Guide to Community Preventive Services*'s methods for systematic reviews were used to evaluate the effectiveness of three interventions to increase safety belt use. Effectiveness was assessed on the basis of changes in safety belt use and number of crash-related injuries.

Results: Strong evidence was found for the effectiveness of safety belt laws in general and for the incremental effectiveness of primary safety belt laws relative to secondary laws. Strong evidence for the effectiveness of enhanced enforcement programs for safety belt laws was also found. Additional information is provided about the applicability, other effects, and barriers to implementation of these interventions.

Conclusions: These reviews form the basis of the recommendations by the Task Force on Community Preventive Services presented elsewhere in this supplement. They can help decision makers identify and implement effective interventions that fit within an overall strategy to increase safety belt use.

Medical Subject Headings (MeSH): community health services; decision making; evidence-based medicine; practice guidelines; preventive health services; public health practice; meta-analysis; review literature; motor vehicles; seat belts; accidents, traffic; wounds and injuries (Am J Prev Med 2001;21(4S):48–65)

Introduction

Although safety belt use has risen dramatically in the United States over the past two decades, increasing belt use remains an important public health priority.[1,2] As recently as 1983, observational studies showed that only 14% of motor vehicle occupants wore safety belts. That number rose to 49% in 1990.[3] By 1995, both observational data collected in 49 states[4] and telephone surveys in all 50 states[5] reported approximately 68% use. Overall, 71% of motor vehicle occupants in 2000 wore safety belts,[6] but certain groups (e.g., teenagers, drinking drivers) consistently report lower than average usage rates.[7–9]

The use of safety belts is the single most effective means of reducing fatal and nonfatal injuries in motor vehicle crashes. In all types of crashes, manual lap–shoulder belts are approximately 45% effective in reducing fatalities in passenger cars and 60% effective in light trucks.[10,11] They are estimated to reduce the risk of serious injury to the head, chest, and extremities by 50% to 83%.[11] Lap belts alone, used most often by rear seat occupants, are estimated to be 17% to 58% effective in preventing death compared with no restraints.[12–14]

Although airbags are in wide use, they provide supplemental protection to lap–shoulder belts. Airbags alone are 10% and 14% effective in reducing deaths and injuries, respectively,[11] whereas airbags and lap–shoulder belts together reduce the risk of death by 50% and injury by 66% in front seats. Thus, increasing and maintaining high levels of safety belt use are essential.

Safety belt use is estimated to have saved 123,000 lives between 1975 and 1999.[15] More lives could be saved if

From the Division of Unintentional Injury Prevention (Dinh-Zarr, Sleet, Shults, Elder) and Office of the Director (Sosin), National Center for Injury Prevention and Control, and Division of Prevention Research and Analytic Methods, Epidemiology Program Office (Zaza), Centers for Disease Control and Prevention, Atlanta, Georgia; Office of Research and Traffic Records, National Highway Traffic Safety Administration (Nichols), Washington, DC; Task Force on Community Preventive Services and the Department of Preventive Care, Group Health Cooperative of Puget Sound (Thompson), Seattle, Washington

Address correspondence and reprint requests to: David A. Sleet, PhD, Division of Unintentional Injury Prevention, Centers for Disease Control and Prevention, 4770 Buford Highway, MS K-63, Atlanta, GA 30341. E-mail: dds6@cdc.gov.

The names and affiliations of the Task Force members are listed in the front of this supplement and at www.thecommunityguide.org.

0749-3797/01/$–see front matter
PII S0749-3797(01)00378-6

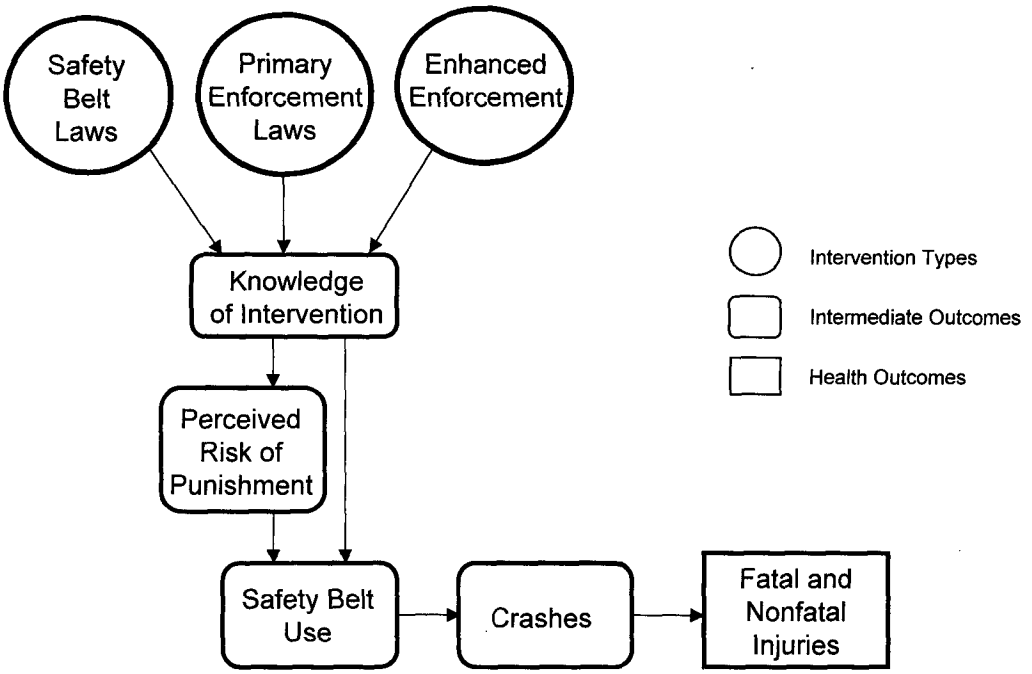


Figure 1. Logic framework for safety belt use interventions.

safety belt use were higher. If all motor vehicle occupants consistently wore safety belts, an estimated 9553 deaths would have been prevented in 1999 alone.[15]

As part of the *Guide to Community Preventive Services* (the *Community Guide*), this review evaluates the effectiveness of three community-based interventions to increase safety belt use: safety belt laws, primary enforcement laws, and enhanced enforcement.

Conceptual Approach

The three interventions reviewed are thought to increase safety belt use by increasing the perceived risk of detection and punishment, as well as establishing the norm that safety belts should be worn. The logic framework shown in Figure 1 depicts the conceptual approach that we developed for the systematic review. This figure illustrates the hypothesized links between the three interventions and the outcomes of interest. Because the effectiveness of safety belts in decreasing fatal and nonfatal injuries is well established, safety belt use alone was considered an acceptable outcome, as were crash-related morbidity and mortality. Vehicle engineering strategies to increase safety belt use, such as automatic safety belts and visual or auditory reminders, were excluded from this review.

Methods

An explanation of the general methods used to conduct these systematic reviews of motor vehicle occupant-related interventions appears elsewhere in this issue.[16] Specifically, for the systematic review of interventions to increase safety belt use, studies were included if: (1) they were published between January 1, 1980, and June 30, 2000, as a journal article or technical report in English; (2) they evaluated safety belt laws in the United States or enhanced enforcement strategies in any country; (3) the intervention was designed to increase safety belt use; and (4) outcome measures included safety belt use, injuries, or fatalities.

Selecting Interventions

A consultation team of subject-matter specialists (see Acknowledgments) generated a comprehensive list of community-based interventions to increase safety belt use and created a priority list of interventions to be reviewed after surveying consultants and other experts. Those consultants and experts polled were asked to consider the following criteria when ranking interventions as priorities for systematic review: Is the intervention (1) thought to be effective but underused; (2) thought to be ineffective but overused; (3) popular, although its effectiveness is not well established; (4) costly, and its effectiveness is not well established; (5) targeted to a specific population of interest (e.g., youth); or (6) broad reaching, and with the potential to achieve large increases in safety belt use? Rankings were compiled, and the six interventions with the most votes were considered to be priorities for this review. Included on the list were the three interventions reviewed in this article plus incentives, mass media, and education programs to increase safety belt use. Reviews of the latter three interventions will be published as they are completed.

Selecting Summary Effect Measures

The primary health outcomes assessed in this literature are safety belt use and fatal and nonfatal injuries resulting from

motor vehicle crashes. Studies used three types of safety belt use data: observed, self-reported, and police-reported. For observed safety belt use, researchers or law enforcement officials directly observed safety belt use by motor vehicle occupants. Self-reported use was determined in telephone surveys, and police-reported use was available from police incident reports of crashes. Police officers record safety belt use on the basis of direct observation and interviews with crash victims. We reported each of these types of safety belt use data separately. For fatal injury data, information about all fatal crashes that occur on public roads in the United States is available in electronic form through the Fatality Analysis Reporting System (FARS) maintained by the National Highway Traffic Safety Administration (NHTSA).[17] There is no comparable national source of electronic information that includes all nonfatal crashes. Studies that reported nonfatal injuries obtained their data from state motor vehicle crash databases and hospital records. Some studies combined fatal and nonfatal injuries into one measure. We reported each of the three types of outcomes (fatal injury, nonfatal injury, and combined) separately.

The methods used to summarize the findings about the effectiveness of an intervention across multiple studies are also described in this issue.[16] Briefly, we graphically displayed the outcomes from individual studies and reported the median effect measure for each outcome. To account for the historically upward trend in safety belt use over time, the latest measurement before the implementation of an intervention was used to estimate the most conservative "before" condition in time series studies, as defined by the *Community Guide*.[a] In addition, the last "post" measurement after the implementation of a law was used when measurements at several time points were available. Because most enhanced enforcement programs have a predetermined end date (unlike ongoing laws), the latest measurement during the enforcement period was used in calculating the effect size. This calculation allowed for the most accurate measure of the cumulative effect of the enhanced enforcement program. In studies with more than one intervention site, we calculated separate effect measures for each site and then took the overall mean for the effect measure. Long-term effects of enhanced enforcement were estimated by using the last measurement taken after the enforcement period ended. Follow-up time was defined as the time between the end of the enforcement period and the last measurement.

Interventions to Increase the Use of Safety Belts

Safety Belt Laws

Safety belt laws mandate the use of safety belts by motor vehicle occupants. All current U.S. laws cover front seat occupants, but other provisions such as rear seat coverage, fines, affected age groups, type of enforcement, and exempted vehicles and drivers vary by state.

Safety belt laws have been a critical component of efforts to increase safety belt use. In the United States, these laws are the purview of the states, but federal standards have played an important role in the enactment of such laws. A 1984 amendment to Federal Motor Vehicle Safety Standard 208 required automobile manufacturers to install automatic restraint systems (airbags or automatic seat belts) unless two thirds of the nation's population was covered by safety belt laws.[18] This amendment stimulated many states to pass laws. By the end of 1999, a total of 49 states, the District of Columbia, Puerto Rico, and all U.S. Territories had adult safety belt laws in place, typically for front seat occupants.

Public awareness of a safety belt law, particularly when accompanied by a perceived risk of detection and punishment, is hypothesized to increase safety belt use. On the basis of studies of motor vehicle crash data, increased use of safety belts results in decreased fatal and nonfatal injuries. Documenting the effectiveness of safety belt laws may prevent their repeal and help strengthen current laws by supporting greater age-range and seating position coverage and removing unnecessary exemptions to the law.

Reviews of evidence

Effectiveness. We identified 46 studies of the effectiveness of safety belt laws, described in Table 1.[19–64] Eight additional studies[65–72] were identified after the systematic review had been completed. Although not included in this review, a preliminary analysis revealed that all reported a beneficial effect of safety belt laws. Details of the 33 qualifying studies are provided at the website (www.thecommunityguide.org).

The 33 qualifying studies revealed consistent increases in safety belt use and consistent decreases in fatal and nonfatal injuries after the enactment of safety belt laws. Table 2 summarizes the effects of safety belt laws on various outcomes. Figure 2 presents the results of studies reporting safety belt use outcomes. Figure 3 presents the results of studies assessing fatal and nonfatal injury outcomes. With the exception of one study, which examined the number of patients with motor vehicle-related injuries admitted to the emergency department of a metropolitan hospital,[29] these data consistently show reductions in fatal and nonfatal injuries, with a median post-law decline of 5%.

Applicability. The study population of this review consisted of individuals older than 5 years. Twelve studies[22,24,27,32,33,35,38,45,50,51,53,57] reported data for populations assumed to be aged 16 years or older (i.e., drivers, university students, employees). One study included only individuals older than 10 years[60] and another only those older than 11 years.[23] Therefore, the applicability of the results of this review may be more relevant to adolescent and adult populations than to older children.

[a]We use the *Community Guide*'s definition of "time series study," which includes any study that obtains multiple measurements before, during, or after an intervention, as well as those using traditional time series analysis. Multiple measurements are equated with a better accounting for trend and are thus given a "moderate" rating in study quality (compared with a "least" rating for before–after studies).

Table 1. Safety belt laws: descriptive information about included studies

	Number of studies
Papers meeting inclusion criteria	46[19–64]
Papers excluded, limited execution quality	11[19,20,30,34,36,37,43,44,46,47,49]
Qualifying papers	35[21–29,31–33,35,38,39–42,45,48,50–64]
Papers reporting on an already-included study	2[31,64]
Actual number of qualifying studies	33[21–29,32,33,35,38–42,45,48,50–63]
Study designs	
Time series with concurrent comparison group	7[25,26,32,40,42,60,63]
Time series, no conccurrent comparison group	17[22,24,27,28,35,38,41,45,50,52,55–59,61,62]
Before–after with concurrent comparison group	1[57]
Before–after, no concurrent comparison group	6[21,23,29,39,48,51]
Cross-sectional	2[33,53]
Outcomes reported	
Fatal injuries	6[38,42,52,55,56,60]
Nonfatal injuries	6[21,23,29,54–56]
Fatal and nonfatal injuries combined	9[25,26,28,39–41,45,52,61]
Observed safety belt use	10[22,24,27,35,50–52,58,59,62]
Police-reported safety belt use	2[48,63]
Self-reported safety belt use	4[32,33,53,57]

Some studies analyzed subpopulations. Women consistently demonstrated a greater increase in safety belt use and usually began at a higher baseline rate of use than did men. Likewise, older drivers tended to exhibit higher use rates.[62] Although adolescents had a lower baseline, their percentage point increase in safety belt use after enactment of a law was similar to increases among all drivers.[50]

Other positive or negative effects. Adults who do not use safety belts are less likely to buckle up the children they transport than adults who use safety belts.[53,60,73,74] Thus, laws that increase safety belt use among adults are also likely to result in increased use among child passengers. One study reported that a law mandating the use of safety belts in the front seat increased use by children aged 2 to 10 years in all positions within the vehicle.[53]

The decrease in fatal and nonfatal injuries associated with increased safety belt use is not as large as might be expected given the known effectiveness of safety belts in decreasing the risk of injury and death.[75,76] One explanation for this is that drivers who are more likely to be involved in serious crashes (e.g., young men, drinking drivers) are least likely to buckle up, especially with relatively weak safety belt laws. In addition, some laws do not apply to all vehicles and others exempt back seat occupants, which could dilute their effects. Another explanation of the discrepancy between predicted and actual reductions in fatalities and injuries is suggested by the concept of risk compensation,[77,78] which postulates that under certain conditions individuals compensate for reduced risk by acting more recklessly. According to this concept, when drivers wear safety belts, they feel safer and exhibit more risky driving behaviors than they otherwise would, thereby reducing the beneficial effects of belt use. Several studies[76,79,80] have sought to determine whether injury reductions resulting from safety belt use are offset by injury increases caused by risky driving after the enactment of a safety belt law, but the evidence remains equivocal. In addition, no studies showed a correlation between increased safety belt use and increased risky driving.[81–83] Thus, the available evidence does not support the concept of risk compensation as it applies to safety belt laws.

Economics. No studies were found that met the requirements for inclusion in a *Community Guide* review.[16]

Table 2. Effectiveness of safety belt laws on various outcomes: summary effects from the body of evidence

Outcome	Number of studies	Median change	Range[a]
Fatal injuries	6[38,42,52,55,56,60]	9% decrease	2%–18% decrease
Nonfatal injuries	6[21,23,29,54–56]	2% decrease	15% decrease to 11% increase
Fatal and nonfatal injuries combined	9[25,26,28,39–41,45,52,61]	8% decrease	3%–20% decrease
Observed safety belt use	10[22,24,27,35,50–52,58,59,62]	33% increase	20%–36% increase
Police-reported safety belt use	2[48,63]	NA	26% increase[b]
Self-reported safety belt use	4[32,33,53,57]	16% increase	13%–19% increase

[a]When 7 or more studies were available, an interquartile range is presented.
[b]One study reported data in a form that could not be converted to our summary effect measures.
NA, not applicable.

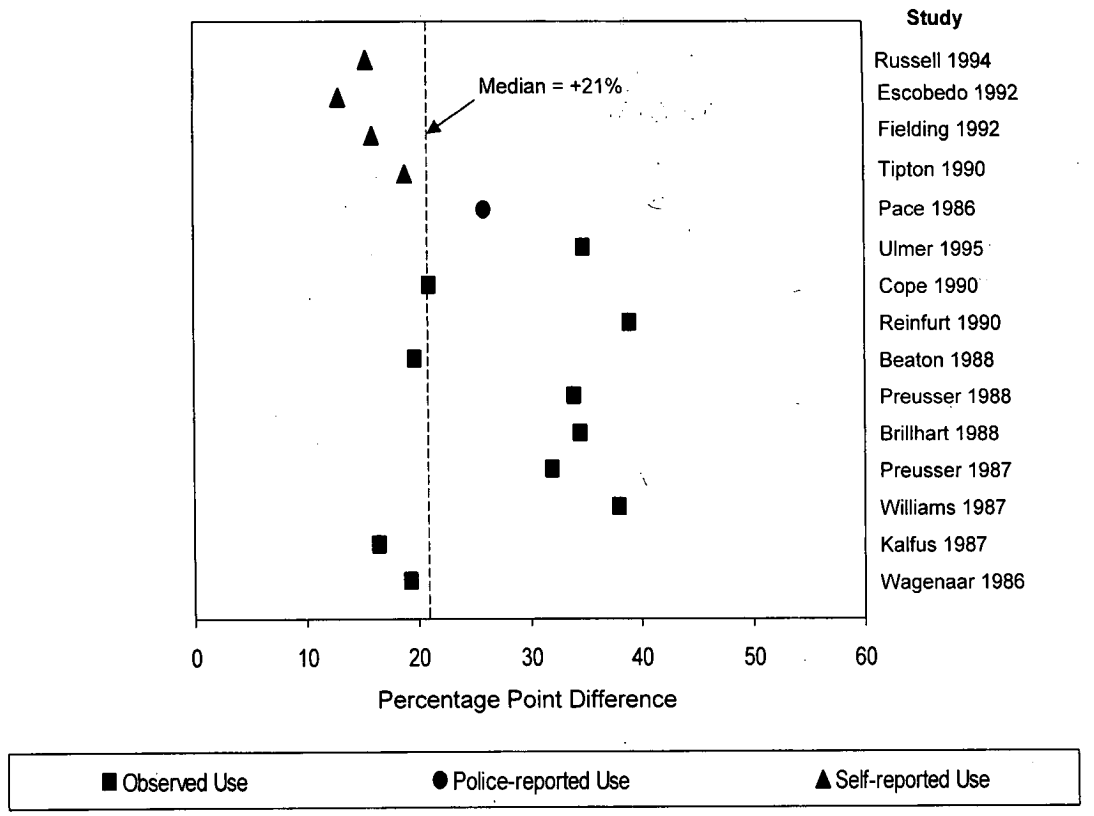


Figure 2. Percentage point difference in safety belt use with safety belt use laws.

Barriers to intervention implementation. As with many legislative interventions, public opposition is a potential barrier to effective implementation. The political climate influences the enactment of laws and their level of enforcement.[84] When states first began enacting safety belt laws, the argument that these laws interfered with personal freedom was common. However, recent surveys conducted by NHTSA report that 86% of individuals aged 16 years and older support safety belt laws, with 63% supporting them "strongly" and 23% supporting them "somewhat."[2]

Conclusion. According to the *Community Guide*'s rules of evidence, available studies provide strong evidence that safety belt laws are effective in increasing safety belt use and decreasing injuries and deaths.

Primary Enforcement Laws

Primary enforcement laws allow a police officer to stop a motorist solely for not wearing a safety belt. In contrast, secondary enforcement laws only allow a police officer to issue a safety belt citation after the motorist has been stopped for another reason.

Australia, New Zealand, Great Britain, and some European countries pioneered the enactment of safety belt laws. All allowed for primary enforcement. In the United States, primary enforcement laws have been the exception rather than the rule. In 1984, New York became the first state to enact a safety belt law. This law contained a primary enforcement provision. New Jersey passed the second safety belt law, but it carried a secondary enforcement provision. In 1993, California became the first state to change from a secondary to a primary enforcement law. Several states followed California's lead and, as of May 2001, a total of 17 states, the District of Columbia, and Puerto Rico had enacted primary enforcement laws.

Police officers find it more difficult to enforce secondary laws than primary laws and are sometimes reluctant to issue tickets because secondary status implies that these laws are of lower priority to legislators, judges, and the general public.[85] Compared with secondary laws, primary laws are hypothesized to have a greater effect on motorists' perceived risk of detection and punishment as well as on the public's view of the importance of safety belt use. Therefore, primary laws may lead to higher rates of safety belt use and lower rates of crash-related fatal and nonfatal injuries.

A previous systematic review[86] evaluated the effectiveness of primary laws implemented in various countries and secondary laws implemented in the United States. All but two of the studies in the review compared the effect of primary or secondary laws with the absence of a law. The investigators concluded that primary laws were likely to be more effective than secondary laws but that more studies directly comparing the effect of

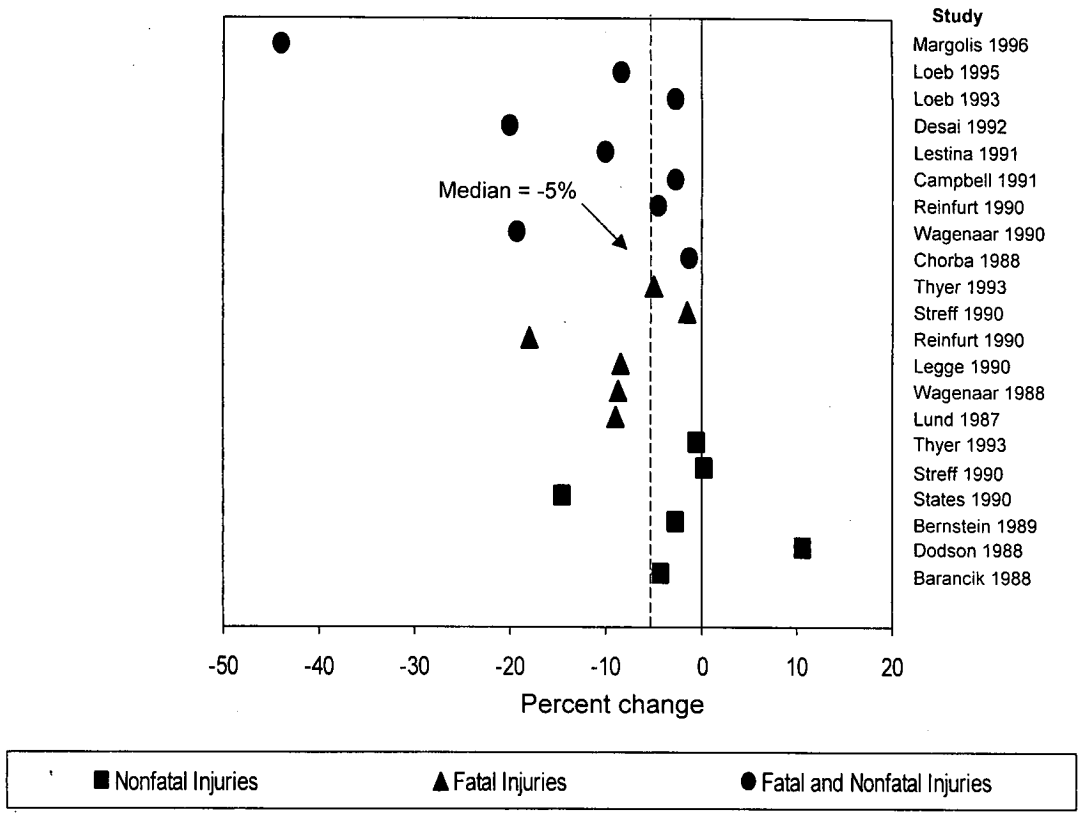


Figure 3. Percent change in fatal and nonfatal injuries with safety belt use laws.

primary laws with secondary laws were needed. The present systematic review only includes studies that directly compare the effects of primary and secondary laws in the United States.

Reviews of evidence

Effectiveness. We identified 19 studies examining the effectiveness of primary enforcement laws, described in Table 3.[8,9,31–33,44,47,58,60,63,76,87–94] Details of the 13 qualifying studies are provided in the Appendix and at the website (www.thecommunityguide.org). Nine studies contained in eight reports[32,33,60,63,76,87–89,94] compared states with primary laws to those with secondary laws, and four studies[8,58,90,91] evaluated the effect of changing from a secondary to a primary law. There were no studies of states changing from a primary law to a secondary law.

Table 4 summarizes the evidence of effectiveness of primary safety belt laws for various outcomes. Figure 4 presents the results of studies containing safety belt use

Table 3. Primary enforcement safety belt laws: descriptive information about included studies

	Number of studies
Papers meeting inclusion criteria	19[8,9,31–33,44,47,58,60,63,76,87–94]
Papers excluded, limited execution quality	2[44,47]
Qualifying papers	17[8,9,31–33,58,60,63,76,87–94]
Papers reporting on an already-included study	5[9,31,89,92,93]
Papers reporting on more than one study	1[63]
Actual number of qualifying studies	13[8,32,33,58,60,63,76,87,88,90,91,94]
Study designs	
Time series with concurrent comparison group	7[32,60,63(two studies),76,87,88]
Time series, no concurrent comparison group	4[8,58,90,91]
Cross-sectional	2[33,94]
Outcomes reported	
Fatal injuries	5[60,63,76,87,88]
Observed safety belt use	5[8,58,90,91,94]
Police-reported safety belt use	1[63]
Self-reported safety belt use	2[32,33]

Table 4. Incremental effectiveness of primary enforcement relative to secondary enforcement safety belt laws on various outcomes: summary effects from the body of evidence

Outcome	Number of studies	Median change	Range[a]
Fatal injuries	5[60,63,76,87,88]	8% decrease[b]	3%–14% decrease
Observed safety belt use	5[8,58,90,91,94]	14% increase	12%–23% increase
Police-reported safety belt use	1[63]	NA	NA[c]
Self-reported safety belt use	2[32,33]	NA	1% and 22% increase

[a]When 7 or more studies were available, an interquartile range is presented.
[b]Two studies reported data in a form that could not be converted to our summary effect measures.
[c]Reported data in a form that could not be converted to our summary effect measures.
NA, not applicable.

outcomes. All 13 included studies showed greater benefits associated with primary laws compared with secondary laws.

Applicability. The studies evaluated primary and secondary safety belt laws in 49 states and the District of Columbia. Primary laws may have a greater effect on high-risk drivers than on low-risk drivers. In California, for example, one study found that the safety belt use rates of drivers with blood alcohol concentrations of 0.10 g/dL or higher increased 39 percentage points after the change to primary enforcement, compared with an overall increase of 23 percentage points.[90] Although belt use in general is higher among whites than nonwhites, two studies showed that with primary enforcement safety belt use increased more among African Americans and Hispanics than among whites.[8,58]

Other positive or negative effects. The positive effects of primary laws should be similar to those of safety belt laws in general (see Safety Belt Laws). If primary safety belt laws are more effective than secondary laws in increasing usage rates among adults, they may also be more effective in increasing usage among their child passengers. Differential enforcement is a potential concern because African Americans and Hispanics may be more likely than whites to be stopped for a safety belt violation. Studies in several states that changed from a secondary to a primary enforcement law, however, found either no difference in the rate of white versus nonwhite ticketing or they found a greater increase in the proportion of whites ticketed after enactment of a primary law.[8,91]

Economics. No studies were found that met the requirements for inclusion in a *Community Guide* review.[16]

Barriers to intervention implementation. Perceived public opposition to primary safety belt laws is a potential barrier to their implementation. Infringement on personal freedom and the potential for differential

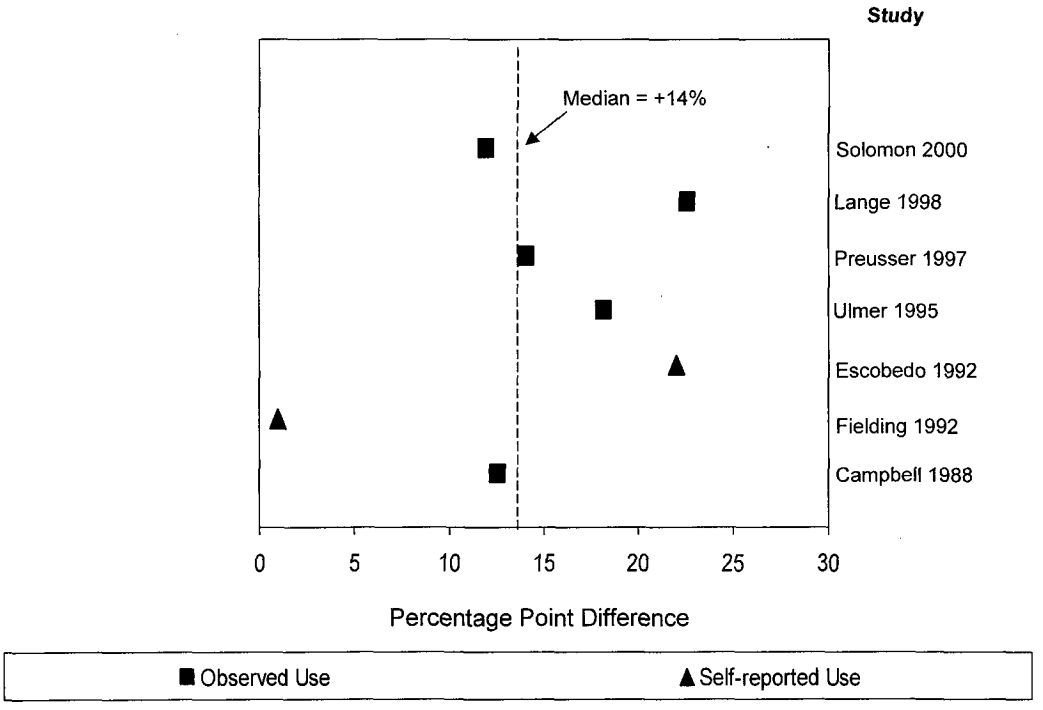


Figure 4. Incremental percentage point difference in safety belt use for primary compared with secondary enforcement laws.

Table 5. Enhanced enforcement: descriptive information about included studies

	Number of studies
Papers meeting inclusion criteria	18[97–114]
Papers excluded, limited execution quality	2[101,114]
Qualifying papers	16[97–100,102–113]
Papers reporting on an already-included study	1[113]
Actual number of qualifying studies	15[97–100,102–112]
Study designs	
Time series with concurrent comparison group	4[99,102,104,106]
Time series, no concurrent comparison group	6[97,98,103,107,108,112]
Before–after with concurrent comparison group	4[100,105,109,111]
Before–after, no concurrent comparison group	1[110]
Outcomes reported	
Fatal and nonfatal injuries combined	2[100,110]
Observed safety belt use	15[97–100,102–112]

enforcement are the most frequently voiced concerns. To increase public acceptance, several states have added anti-harassment language to their primary safety belt legislation to reduce potential for differential enforcement and most have highlighted the potential safety benefits.[85] As with safety belt laws in general, public support for primary laws appears to be strong. In 1998, 58% of U.S. residents supported primary laws, with support higher in states with primary laws (68%) than in states with secondary laws (50%).[95]

Conclusion. According to the *Community Guide*'s rules of evidence, available studies provide strong evidence that primary safety belt laws are more effective than secondary laws in increasing safety belt use and decreasing fatalities.

Enhanced Enforcement

Enhanced enforcement of safety belt laws can involve increasing the number of officers on patrol, increasing citations for safety belt violations during regular patrols, use of safety belt checkpoints, or a combination of these efforts. These programs are conducted in addition to a state's normal enforcement practices and are coupled with publicity to promote increased compliance with a state's safety belt law. For comparative purposes, we refer to increases in the number of officers on patrol as "supplemental patrols" and efforts to increase citations during regular patrols as "targeted patrols."

Enhanced enforcement programs may vary with respect to timing. They may be intense efforts of short duration (called waves or blitzes) that last for days or weeks and may be repeated periodically, or they may attempt to maintain continuous enforcement levels over several weeks, months, or years. Enhanced enforcement programs are often referred to as Selective Traffic Enforcement Programs (STEPs) or Special Traffic Enforcement Programs (sTEPs).[96]

Enhanced enforcement programs are designed to increase public awareness of efforts to enforce safety belt use laws through accompanying media campaigns and direct encounters on the road. This increased awareness is expected to increase the perceived risk of being detected and punished for failing to wear a safety belt, resulting in increased safety belt use and fewer injuries and deaths. Both the level of publicity and visibility of enforcement may influence the risk perception and behavior of motorists. This review focuses on enhanced enforcement programs that specifically target safety belt use and excludes studies of programs that target multiple unsafe driving practices.

Reviews of evidence

Effectiveness. We identified 18 studies of enhanced enforcement programs that specifically target safety belt use, described in Table 5.[97–114] The reported outcomes in the 15 qualifying studies were observed safety belt use and a combined measure of fatal and nonfatal injuries. Summary effects are shown in Table 6. Details of the 15 studies are provided at the website (www.thecommunityguide.org). Figure 5 presents the results of studies of observed safety belt use. The evidence indicates that enhanced enforcement programs are associated with an increase in safety belt use and a decrease

Table 6. Effectiveness of enhanced enforcement on various outcomes: summary effects from the body of evidence

Outcome	Number of studies	Median change	Range[a]
Fatal and nonfatal injuries combined	2[100,110]	NA	7% and 15% decrease
Observed safety belt use	15[97–100,102–112]	16% increase	8%–24% increase

[a]When 7 or more studies were available, an interquartile range is presented.
NA, not applicable.

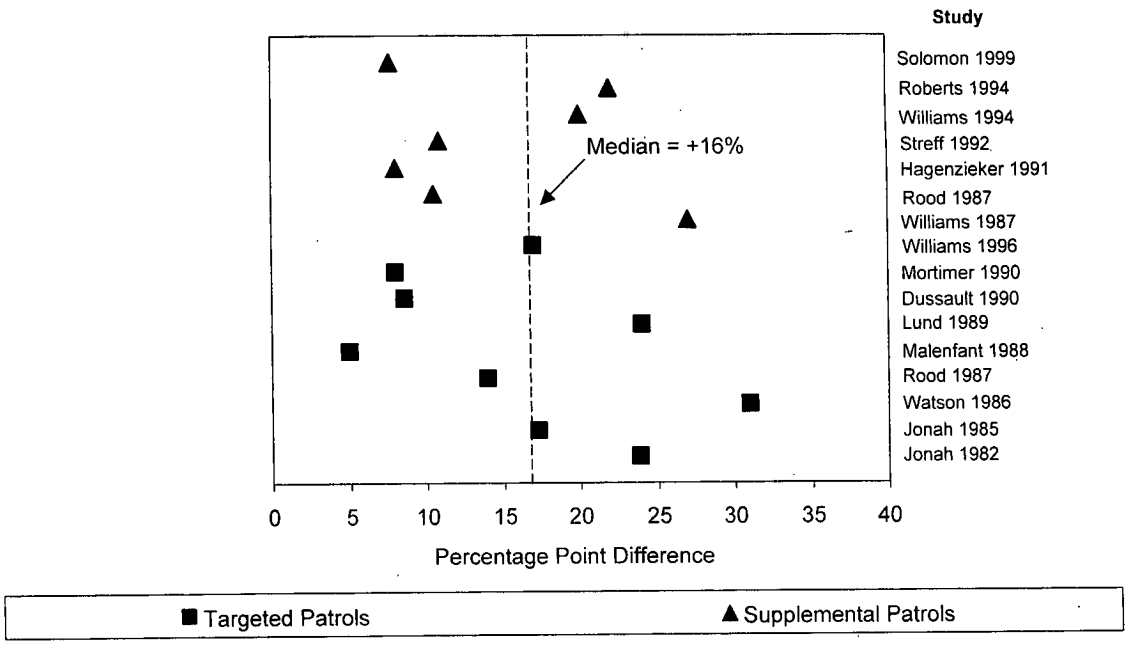


Figure 5. Percentage point difference in observed safety belt use for two methods of enhanced enforcement.

in injuries. Increases in safety belt use were similar for targeted patrols and supplemental patrols (Figure 5).

Two enhanced enforcement programs[97,112] included an incentive component for which the effect could not be measured independently. The increases in safety belt use associated with these programs (9% and 20%, respectively) were similar to the overall effect of enhanced enforcement on safety belt use. Some studies reported the number of citations that were issued during the enhanced enforcement period compared with other periods. These data were difficult to aggregate because of their heterogeneity, but details of the reported citation information are available at the website (www.thecommunityguide.org). One study[105] reported that increases in safety belt use were related to the ratios of both officers-to-residents (r=0.70; p<0.027) and citations-to-residents (r=0.86; p<0.003).

On the basis of information from 11 programs that collected follow-up data (contained in 10 reports),[97–99,102–104,106,108,110,111] safety belt use rates declined somewhat in the months after enhanced enforcement programs ended (median change in safety belt use rates at final follow-up, −6%; interquartile range, −8% to 0%). As has been observed elsewhere,[107] however, belt use rates consistently remained above pre-intervention baseline levels (median change, +9%; interquartile range, 7% to 14%) despite these declines (Figure 6). Although long-term effects remain open to question, some investigators have suggested that optimal rates may be achieved by combining continuous enforcement with waves or blitzes of enhanced enforcement.[106]

Applicability. The studies evaluated enhanced enforcement programs conducted in a variety of settings in the United States and Canada. They included programs implemented at city, county, state, provincial, and national levels, involving varying levels of publicity and enforcement climates. Two U.S. studies that stratified results by population density found greater increases in safety belt use in suburban and rural areas than in urban areas.[106,110]

Other positive or negative effects. Enhanced enforcement of safety belt laws may lead to increased arrests for other crimes such as possession of weapons or drugs, impaired driving, or license violations. For example, the North Carolina "Click It or Ticket" programs, which operated for 2 months in 1993 and 1 month in 1994, reported arresting 56 fugitives, recovering 46 stolen vehicles, and stopping 2094 alcohol-impaired drivers.[110]

Economics. No studies were found that met the requirements for inclusion in a *Community Guide* review.[16]

Barriers to intervention implementation. State and community officials may resist implementing an enhanced enforcement program because of concerns that the public might oppose it. However, two statewide telephone surveys conducted in California and North Carolina during such operations[102,110] indicated that 70% and 87% of respondents, respectively, were in favor of enhanced enforcement programs to increase safety belt use. Some police officers may be concerned that participating in enhanced enforcement programs will divert them from investigating more serious crimes. One study included in this review documented crime rates during enhanced enforcement periods and found no increase.[110] Although hesitancy on the part of the police and community officials to implement enhanced

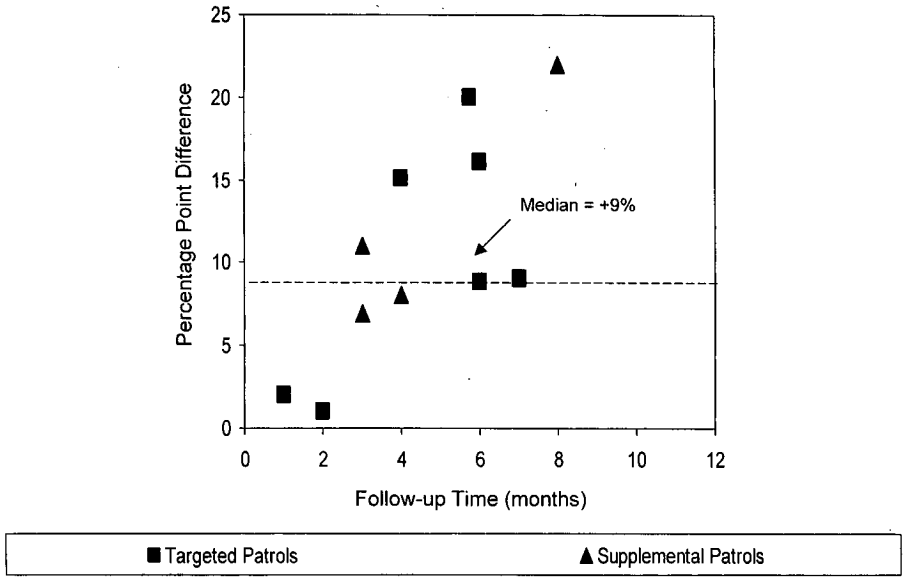


Figure 6. Percentage point difference in observed safety belt use by follow-up time for two methods of enhanced enforcement.

enforcement may be a barrier, interviews with both police and the public have revealed increasingly positive attitudes toward enhanced safety belt enforcement programs.[95]

Conclusion. According to the *Community Guide*'s rules of evidence, available studies provide strong evidence that enhanced enforcement is effective in increasing safety belt use.

Research Issues

Effectiveness

There is strong evidence for the effectiveness of the three interventions reviewed. However, important research issues related to the effectiveness of these interventions remain.

Safety belt laws

- To what extent does the level of enforcement and publicity influence the effectiveness of safety belt laws?
- Does the severity of fines have any bearing on the effectiveness of the laws?
- Do other penalties (e.g., license demerits) add to the effectiveness of the laws?
- Do exemptions for certain vehicles and occupants reduce the effectiveness of the laws?

Primary safety belt laws

- What are the age, gender, and racial differences between violators in primary and secondary law states?
- Are primary enforcement laws more or less effective in certain populations?

Enhanced enforcement

- How does the length and frequency of enhanced enforcement programs influence their effectiveness?
- Does the effectiveness of enhanced enforcement programs vary based on the scale of the interventions (e.g., single community vs multi-community programs)?
- How do publicity, public education, and news coverage affect enhanced enforcement programs?

Applicability

All three interventions appear to be effective in most populations and settings. Although some differences in effectiveness for subgroups have been identified in these reviews, other questions regarding differential effectiveness of these interventions remain.

- What penalties for violations of laws (e.g., fines, license demerits) are most effective among high-risk drivers (e.g., teenagers, drinking drivers)?
- What are the most effective methods of publicizing enhanced enforcement to reach high-risk drivers?

Other Positive or Negative Effects

Research on the positive and negative effects of each intervention might include:

- Do primary safety belt laws increase or decrease risky driving?
- Do enhanced enforcement programs for safety belt use decrease risky driving?
- Do primary laws or enhanced enforcement programs deter alcohol-impaired driving?
- Are primary laws associated with changes in fre-

quency of traffic stops for ethnic and racial minorities relative to the general population?

Economic Evaluations

Little economic evaluation information was available. Research is warranted to answer the basic economic questions: What are the cost-benefit, cost utility, and cost-effectiveness of interventions to increase safety belt use?

Barriers

A number of barriers impede effective implementation of each intervention reviewed. Research into the following areas may help to overcome these barriers.

- How can communities increase public acceptance of primary safety belt laws?
- Do enhanced enforcement programs divert police from other crimes?

Discussion

These reviews examined interventions to increase safety belt use among individuals older than 5 years. An accompanying article in this supplement[115] addresses interventions to increase use of child safety seats by children aged birth to 4 years. A clear gap in these two sets of reviews and in the Task Force's recommendations is for children who are too old or too large to sit in child safety seats but who are too small to wear safety belts without the use of booster seats (generally children aged 4 to 8 years).[116] The literature base regarding the efficacy of booster seats, and particularly that of population-based interventions to improve their use, is still emerging. Future updates of these reviews and recommendations should address this vulnerable population.

We thank the following individuals for their contributions to this review: Erin Finley, Krista Hopkins, and Patryce Young-Curtis, *Research Assistants*; Vilma G. Carande-Kulis and Mary Olufemi Alao, *Economics Team*; Sandra Bonzo and Joanna Taliano, *Research Librarians*; Kate W. Harris, *Editor*; our **Consultation Team**—J. C. Bolen, PhD, MPH, National Center for Chronic Disease Prevention and Health Promotion, CDC, Atlanta, GA; R. D. Brewer, MD, MSPH, Nebraska Department of Health, Lincoln; S. D. Bryn, MPH, Health Resources Services Administration, Rockville, MD; F. M. Council, PhD, University of North Carolina, Chapel Hill; R. W. Denniston, MA, Substance Abuse and Mental Health Services Administration, Rockville, MD; A. C. Gielen, ScD, ScM, Johns Hopkins University, Baltimore, MD; S. Gorcowski, MA, National Highway Traffic Safety Administration, Washington, DC; C. A. Hurley, BA, National Safety Council, Washington, DC; T. A. Karlson, PhD, University of Wisconsin, Madison; M. R. Kinde, MPH, Minnesota Department of Health, Minneapolis; D. W. Lawrence, MPH, RN, San Diego State University, CA; S. E. Martin, PhD, National Institute for Alcohol Abuse and Alcoholism, Rockville, MD; J. A. McKnight, PhD, National Public Service Research Institute, Landover, MD; A. D. Mickalide, PhD, CHES, National SAFE KIDS Campaign, Washington, DC; L. F. Novick, MD, MPH, Onandaga County Department of Health, Syracuse, NY; F. P. Rivara, MD, MPH, University of Washington, Seattle; C. W. Runyan, PhD, MPH, University of North Carolina, Chapel Hill; R. J. Smith, MS, Health Resources and Services Administration, Rockville, MD; P. F. Waller, PhD, University of Michigan, Ann Arbor; A. F. Williams, PhD, Insurance Institute for Highway Safety, Arlington, VA; and our **Abstraction Team**—J. Oh, MD, MPH, Harrisburg, PA; D. Pallin, MD, MPH, Mt. Sinai School of Medicine, New York, NY; E. Shipp, MS, University of Texas School of Public Health, Houston; D. Sudakin, MD, MPH, Oregon State University, Corvallis; D. White, PhD, MPH, University of Texas School of Public Health, Houston.

References

1. Sleet DA. Motor vehicle trauma and safety belt use in the context of public health priorities. J Trauma 1987;27:695–702.
2. National Highway Safety Administration. Buckle Up America: the presidential initiative for increasing seat belt use nationwide. First report to Congress. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1998. DOT HS 808 667.
3. National Highway Traffic Safety Administration. Restraint system use in 19 U.S. cities. 1991 annual report. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1992. DOT HS 808 148.
4. National Highway Traffic Safety Administration. Traffic safety facts 1995. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, 1996. DOT HS 808 471.
5. Powell-Griner E, Anderson JE, Murphy W, Coordinators for the Behavioral Risk Factor Surveillance System. State- and sex-specific prevalence of selected characteristics—Behavioral Risk Factor Surveillance System, 1994 and 1995. MMWR CDC Surveill Summ 1997;46(SS-03):1–29.
6. National Highway Traffic Safety Administration. Observed safety belt use from December 1999 and June 2000. MiniNOPUS. Research Note. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000.
7. Kann L, Warren CW, Harris WA, et al. Youth risk behavior surveillance–United States, 1995. MMWR CDC Surveill Summ 1996;45(SS-4):1–83.
8. Preusser DF, Preusser CW. Evaluation of Louisiana's safety belt law change to primary enforcement. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1997. DOT HS 808 620.
9. Ulmer RG, Preusser CW, Preusser DF. Evaluation of California's safety belt law change to primary enforcement. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1994. DOT HS 808 205.
10. Evans L. The effectiveness of safety belts in preventing fatalities. Accid Anal Prev 1986;18:229–41.
11. National Highway Traffic Safety Administration. Fourth report to Congress: effectiveness of occupant protection systems and their use. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1999. DOT HS 808 919.
12. Kahane CJ. Fatality and injury reducing effectiveness of lap belts for back seat occupants. Warrendale, PA: Society of Automotive Engineers, 1987. Paper No 870486.
13. Evans L. Traffic safety and the driver. New York: Van Nostrand Reinhold, 1991.
14. Padmanaban J, Ray R. Safety performance of rear seat occupant restraint systems. 36th STAPP Car Crash Conference Proceedings. Warrendale, PA: Society of Automotive Engineers, 1992. SAE Publication No P-261.
15. National Highway Traffic Safety Administration. Traffic safety facts 1999: occupant protection. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 090.
16. Zaza S, Carande-Kulis VG, Sleet DA, et al. and the Task Force on Community Preventive Services. Methods for conducting systematic re-

views of the evidence of effectiveness and economic efficiency of interventions to reduce injuries to motor vehicle occupants. Am J Prev Med 2001;21(suppl 4):23–30.
17. National Highway Traffic Safety Administration. Traffic safety facts, 1999: a compilation of motor vehicle crash data from the Fatality Analysis Reporting System and the General Estimates System. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 100.
18. National Highway Traffic Safety Administration. Final regulatory impact analysis. Amendment to Federal Motor Vehicle Safety Standard 208. Passenger car front seat occupant protection. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1984. DOT HS 806 572.
19. Adeyanju M. Public knowledge, attitudes, and behavior toward Kansas mandatory seatbelt use: implications for public health policy. J Health Soc Policy 1991;3:117–35.
20. Centers for Disease Control and Prevention. Safety-belt use and motor vehicle-related injuries—Navajo nation, 1988–1991. MMWR 1992;41: 705–8.
21. Barancik JI, Kramer CF, Thode HC Jr, Harris D. Efficacy of the New York State seat belt law: preliminary assessment of occurrence and severity. Bull N Y Acad Med 1988;64:742–9.
22. Beaton SJ, Pearson GL, Arnegard RJ, Quinn KD. A field evaluation of the effectiveness of the Virginia safety belt law. Forensic Rep 1988;1:229–36.
23. Bernstein E, Pathak D, Rutledge L, Demarest G. New Mexico safety restraint law: changing patterns of motor vehicle injury, severity, and cost. Am J Emerg Med 1989;7:271–7.
24. Brillhart BA, Jay HM. The impact of Texas state legislation on the use of safety belts. Rehabil Nurs 1988;13:146–9.
25. Campbell BJ, Stewart JR, Reinfurt DW. Change in injuries associated with safety belt laws. Accid Anal Prev 1991;23:87–93.
26. Chorba TL, Reinfurt D, Hulka BS. Efficacy of mandatory seat-belt use legislation. The North Carolina experience from 1983 through 1987. JAMA 1988;260:3593–7.
27. Cope JG, Johnson AW, Grossnickle WF. Behavior engineering proposals: 3. Effects on drivers and passengers of a mandatory use law for safety belts. Percept Mot Skills 1990;71:291–8.
28. Desai A, You MB. Policy implications from an evaluation of seat belt use regulation. Eval Rev 1992;16:247–65.
29. Dodson TB, Kaban LB. California mandatory seat belt law: the effect of recent legislation on motor vehicle accident related maxillofacial injuries. J Oral Maxillofac Surg 1988;46:875–80.
30. Durant RF, Legge JS. Policy design, social regulation and theory building: lessons from the traffic safety policy arena. Political Res Q 1993;46:641–56.
31. Escobedo LG, Chorba TL, Remington PL, Anda RF, Sanderson L, Zaidi AA. State laws and the use of car safety seat belts. N Engl J Med 1991;325:1586–7.
32. Escobedo LG, Chorba TL, Remington PL, Anda RF, Sanderson L, Zaidi AA. The influence of safety belt laws on self-reported safety belt use in the United States. Accid Anal Prev 1992;24:643–53.
33. Fielding JE, Knight KK, Goetzel RZ. The impact of legislation on self-reported safety belt use in a working population. J Occup Med 1992;34:715–7.
34. Geller ES. Intervening to increase children's use of safety belts. Alcohol Drugs Driving 1989;5:37–59.
35. Kalfus GR, Ferrari JR, Arean P, et al. An examination of the New York mandatory seat belt law on a university campus. Law Hum Behav 1987;11:63–7.
36. Kuric J, Harrison C. Spinal cord injuries and a mandatory seat belt law. SCI Nurs 1989;6:29–31.
37. Latimer EA, Lave LB. Initial effects of the New York State auto safety belt law. Am J Public Health 1987;77:183–6.
38. Legge JS Jr. Reforming highway safety in New York state: an evaluation of alternative policy interventions. Soc Sci Q 1990;71:373–82.
39. Lestina DC, Williams AF, Lund AK, Zador P, Kuhlmann TP. Motor vehicle crash injury patterns and the Virginia seat belt law. JAMA 1991;265:1409–13.
40. Loeb PD. Effectiveness of seat belt legislation in reducing various driver-involved injury rates in California. Accid Anal Prev 1993;25:189–97.
41. Loeb PD. The effectiveness of seat belt legislation in reducing injury rates in Texas. Am Econ Rev 1995;85:81–4.
42. Lund AK, Pollner J, Williams AF. Preliminary estimates of the effects of mandatory seat belt use laws. Accid Anal Prev 1987;19:219–23.
43. Maguire B, Faulkner W. Safety belt laws and traffic fatalities. J Appl Soc 1990;7:49–61.
44. Maguire B, Faulkner WR, Mathers RA. Seat belt laws and traffic fatalities: a research update. Soc Sci J 1996;33:321–33.
45. Margolis LH, Bracken J, Stewart JR. Effects of North Carolina's mandatory safety belt law on children. Inj Prev 1996;2:32–5.
46. Mortimer RG, Phillippo C. Before and after study reveals public attitude and ignorance toward mandatory seat belt use. Traffic Safety 1985;85: 10–1, 25.
47. Nelson DE, Bolen J, Kresnow M. Trends in safety belt use by demographics and by type of state safety belt law, 1987 through 1993. Am J Public Health 1998;88:245–9.
48. Pace BW, Thailer R, Kwiatkowski TG. New York State mandatory seatbelt use law: patterns of seatbelt use before and after legislation. J Trauma 1986;26:1031–3.
49. Petrucelli E. Seat belt laws: the New York experience—preliminary data and some observations. J Trauma 1987;27:706–10.
50. Preusser DF, Williams AF, Lund AK. The effect of New York's seat belt use law on teenage drivers. Accid Anal Prev 1987;19:73–80.
51. Preusser DF, Lund AK, Williams AF, Blomberg RD. Belt use by high-risk drivers before and after New York's seat belt use law. Accid Anal Prev 1988;20:245–50.
52. Reinfurt DW, Campbell BJ, Stewart JR, Stutts JC. Evaluating the North Carolina safety belt wearing law. Accid Anal Prev 1990;22:197–210.
53. Russell J, Kresnow M, Brackbill R. Effect of adult belt laws and other factors on restraint use for children under age 11. Accid Anal Prev 1994;26:287–95.
54. States JD, Annechiarico RP, Good RG, et al. A time comparison study of the New York State safety belt use law utilizing hospital admission and police accident report information. Accid Anal Prev 1990;22:509–21.
55. Streff F, Wagenaar AC, Schultz RH. Reductions in police-reported injuries associated with Michigan's safety belt law. J Safety Res 1990;21:9–18.
56. Thyer BA, Robertson M. An initial evaluation of the Georgia safety belt use law: a nul MUL? Environment Behav 1993;25:506–13.
57. Tipton RM, Camp CC, Hsu K. Effects of mandatory seat belt legislation on self-reported seat belt use among male and female college students. Accid Anal Prev 1990;22:543–8.
58. Ulmer RG, Preusser CW, Preusser DF, Cosgrove LA. Evaluation of California's safety belt law change from secondary to primary enforcement. J Safety Res 1995;26:213–20.
59. Wagenaar AC, Wiviott MB. Effects of mandating seatbelt use: a series of surveys on compliance in Michigan. Public Health Rep 1986;101:505–13.
60. Wagenaar AC, Maybee RG, Sullivan KP. Mandatory seat belt laws in eight states: a time-series evaluation. J Safety Res 1988;19:51–70.
61. Wagenaar AC, Margolis LH. Effects of a mandatory safety belt law on hospital admissions. Accid Anal Prev 1990;22:253–61.
62. Williams AF, Wells JK, Lund AK. Shoulder belt use in four states with belt use laws. Accid Anal Prev 1987;19:251–60.
63. Winnicki J. Safety belt use laws: evaluation of primary enforcement and other provisions. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1995. DOT HS 808 324.
64. Reinfurt DW, Stewart JR, Weaver NL, Green AM. Occupant restraint monitoring program. Chapel Hill, NC: University of North Carolina Highway Safety Research Center, 1991. No HSRC-PR183.
65. Asch P, Levy D. An evaluation of the New Jersey safety belt use law. Newark, NJ: Rutgers University, Bureau of Economic Research, 1989.
66. Carter E, Schonfeld P. Safety belt use and highway safety in Maryland. Washington, DC: Transportation Research Board, 1991. Transportation Research Record No 1325.
67. Curtis C, Lovrich NP. Report to the Washington State Legislature: the impact of the 1986 mandatory safety belt use law. Pullman, WA: Division of Governmental Studies and Services, Washington State University, 1988.
68. Datta TK, Guzek P. Restraint system use in 19 U.S. cities—1989 annual report. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1990. DOT HS 807 595.
69. Hall WL, Tolbert WG, Cox CL, Lowrance JC. Comprehensive program for increasing use of safety seats and seat belts for children and young adults: final report 1992. Chapel Hill, NC: University of North Carolina Highway Safety Research Center, 1993. UNC/HSRC-93/3/1.
70. Highway Loss Data Institute. Insurance Special Report: insurance injury loss experience in eight states with seat belt laws, 1983–1986 models. Washington, DC: Highway Loss Data Institute, 1988. HLDI A-28, HS-040 523.
71. Rock SM. Impact of the Illinois seat belt use law on accidents, deaths, and injuries. Eval Rev 1992;16:491–507.
72. Stoke CB. An observational survey of safety belt and child safety seat use

in Virginia: the 1990 update. Charlottesville, VA: Virginia Transportation Research Council, 1992. VTRC 92 R22.
73. Centers for Disease Control and Prevention. Impact of adult safety-belt use on restraint use among children <11 years of age—selected states, 1988 and 1989. MMWR 1993;42(14):275–8.
74. Macknin ML, Gustafson C, Gassman J, Barich D. Office education by pediatricians to increase seat belt use. Am J Dis Child 1987;141:1305–7.
75. Graham JD. Injuries from traffic crashes: meeting the challenge. Annu Rev Public Health 1993;14:515–43.
76. Evans WN, Graham JD. Risk reduction or risk compensation? The case of mandatory safety-belt use laws. J Risk Uncertainty 1991;4:61–73.
77. Richens J, Imrie J, Copas A. Condoms and seatbelts: the parallels and the lessons. Lancet 2000;355(9201):400–3.
78. Wilde GJ. Risk homeostasis theory: an overview. Inj Prev 1998;4:89–91.
79. Asch P, Levy D, Shea D, Bodenhorn H. Risk compensation and the effectiveness of safety belt use laws: a case study of New Jersey. Policy Sci 1991;24:181–97.
80. Garbacz C. More evidence on the effectiveness of seat belt laws. Appl Econ 1992;24:313–5.
81. Lund AK, Zador P. Mandatory belt use and driver risk taking. Risk Anal 1984;4:41–53.
82. O'Neill B, Lund AK, Zador P, Ashton S. Mandatory belt use and driver risk taking: an empirical evaluation of the risk-compensation hypothesis. In: Evans L, Schwing RC, eds. Human Behavior and Traffic Safety (GM Symposium Series). New York, NY: Plenum Press, 1985:93–118.
83. Evans L, Wasielewski P, Von Buseck CR. Compulsory seat belt usage and driver risk-taking behavior. Hum Factors 1982;24:41–8.
84. Longest BB. Health policymaking in the United States. Chicago, IL: Health Administration Press, 1994.
85. Russell N, Dreyfuss M, Cosgrove M, Low & Associates. Legislative history of recent primary safety belt laws. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1999. DOT HS 808 833.
86. Rivara FP, Thompson DC, Cummings P. Effectiveness of primary and secondary enforced seat belt laws. Am J Prev Med 1999;16(suppl 1):30–9.
87. Houston DJ, Richardson LE, Neeley GW. Legislating traffic safety: a pooled time series analysis. Soc Sci Q 1995;76:328–45.
88. Houston DJ, Richardson LE, Neeley GW. Mandatory seat belt laws in the states: a study of fatal and severe occupant injuries. Eval Rev 1996;20:146–59.
89. Hoxie P, Skinner D. Effects of mandatory seat belt use laws on highway fatalities in 1985. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1987. DOT HS 807 083.
90. Lange JE, Voas RB. Nighttime observations of safety belt use: an evaluation of California's primary law. Am J Public Health 1998;88:1718–20.
91. Solomon MG, Nissen WJ. Evaluation of Maryland, Oklahoma, and the District of Columbia's seat belt law change to primary enforcement. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 213.
92. Campbell BJ. The relationship of seat belt law enforcement to level of belt use. Chapel Hill, NC: University of North Carolina Highway Safety Research Center, 1987. No HSRC-TR72.
93. Wagenaar AC, Maybee RG, Sullivan KP. Effects of mandatory seat belt laws on traffic fatalities in the first eight states enacting seat belt laws. Ann Arbor, MI: University of Michigan Transportation Research Institute, 1987. UMTRI-87-18.
94. Campbell BJ. The association between enforcement and seat belt use. J Safety Res 1988;19:150–63.
95. National Highway Traffic Safety Administration. 1998 Motor Vehicle Occupant Safety Survey. Volume 2: Seatbelt report. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 051.
96. National Highway Traffic Safety Administration. Steps for conducting sTEPs. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1995. DOT HS 808 458.
97. Dussault C. Effectiveness of a Selective Traffic Enforcement Program combined with incentives for seat belt use in Quebec. Health Educ Res 1990;5:217–23.
98. Hagenzieker MP. Enforcement or incentives? Promoting safety belt use among military personnel in the Netherlands. J Appl Behav Anal 1991; 24:23–30.
99. Jonah BA, Dawson NE, Smith GA. Effects of a selective traffic enforcement program on seat belt usage. J Appl Psychol 1982;67:89–96.
100. Jonah BA, Grant BA. Long-term effectiveness of selective traffic enforcement programs for increasing seat belt use. J Appl Psychol 1985;70:257–63.
101. Jones R, Joksch H, Lacey J, Wiliszowski C, Marchetti L. Site report: Knoxville, Tennessee field test of combined speed, alcohol and safety belt enforcement strategies. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1995. DOT HS 808 243.
102. Lund AK, Stuster J, Fleming A. Special publicity and enforcement of California's belt use law: making a "secondary" law work. J Criminal Justice 1989;17:329–41.
103. Malenfant JE, Van Houten R. The effects of nighttime seat belt enforcement on seat belt use by tavern patrons: a preliminary analysis. J Appl Behav Anal 1988;21:271–6.
104. Mortimer RG, Goldsteen K, Armstrong RW, Macrina D. Effects of incentives and enforcement on the use of seat belts by drivers. J Safety Res 1990;21:25–37.
105. Roberts DS, Geller ES. A statewide intervention to increase safety belt use: adding to the impact of a belt use law. Am J Health Promot 1994;8:172–4.
106. Rood DH, Kraichy PP, Carman JA. Selective Traffic Enforcement Program for occupant restraints. Final report. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1987. DOT HS 807 120.
107. Solomon MG, Nissen WJ, Preusser DF. Occupant protection Special Traffic Enforcement Program evaluation. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1999. DOT HS 808 884.
108. Streff FM, Molnar LJ, Christoff C. Increasing safety belt use in a secondary enforcement state: evaluation of a three-county special enforcement program. Accid Anal Prev 1992;24:369–83.
109. Watson REL. The effectiveness of increased police enforcement as a general deterrent. Law Society Rev 1986;20:293–9.
110. Williams AF, Reinfurt D, Wells JK. Increasing seat belt use in North Carolina. J Safety Res 1996;27:33–41.
111. Williams AF, Lund AK, Preusser DF, Blomberg RD. Results of a seat belt use law enforcement and publicity campaign in Elmira, New York. Accid Anal Prev 1987;19:243–9.
112. Williams AF, Hall WL, Tolbert WG, Wells JK. Development and evaluation of pilot programs to increase seat belt use in North Carolina. J Safety Res 1994;25:167–75.
113. Williams AF, Preusser DF, Blomberg RD, Lund AK. Seat belt use law enforcement and publicity in Elmira, New York: a reminder campaign. Am J Public Health 1987;77:1450–1.
114. Mounce NH, Brackett RQ, Womack KN. Evaluation on six occupant protection selective traffic enforcement programs in Texas. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1990. Contract No DTNH22-89-C-05192.
115. Zaza S, Sleet DA, Thompson RS, Sosin DM, Bolen JC, Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of child safety seats. Am J Prev Med 2001;21(suppl 4):31–47.
116. Centers for Disease Control and Prevention. Motor-vehicle occupant fatalities and restraint use among children aged 4–8 years. United States, 1994–1998. MMWR 2000;49(07):135–7.

Appendix 1: Studies Measuring the Incremental Effect of Primary Enforcement Laws Relative to Secondary Enforcement Laws on Fatal Injuries

Author, Year Study period Design suitability (design) Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Effect measure	Reported baseline	Reported effect	Value used in summary[a]	Follow-up time[b]
Wagenaar 1988 [1] 1976-1986 Greatest (time series with concurrent comparison) Fair 12 states (Primary: IL, NY, TX; Secondary: MI, NE, NJ; No Law: GA, IN, KS, MD, OH, PA)	Age: Not stated (adults) Position: Front Vehicles: Passenger, vans, light trucks, utility vehicles Fines: Not stated Effective Dates: Varied Comparison: Primary vs secondary law states	Front seat motor vehicle occupants age 10 and over in U.S. 12 states	Fatalities per vehicle mile traveled (VMT) (Paper did not state the specific multiple of VMT used in calculating fatality rates)	NA	Percent change in fatalities per VMT: Secondary Law: -6.8 (p<.05) Primary Law: - 9.9 (p<.05)	-3.1%	9-19 months
Evans 1991 [2] 1975-1987 Greatest (time series with concurrent comparison) Fair 48 U.S. states (MA, NE excluded)	Age: All Position: Not stated Vehicles: Not stated Fines: Not stated Effective Dates: Varied Comparison: Primary vs secondary law states	All motor vehicle occupants in U.S. 48 states	Fatalities per 100 million VMTs	NA	Percent change in rate of fatalities per VMT: Primary Law: -17% (p<.01) Secondary Law: -3.1% (N.S.)	-13.9%	0-3 years
Winnicki 1995 Appendix Update of Hoxie 1987 [3] 1975-1994 Greatest (time series with concurrent comparison) Fair [based on Hoxie 1987] 50 U.S. states	Age: Not stated Position: Front Vehicles: Passenger Fines: Not stated Effective Dates: Varied [based on Hoxie 1987] Comparison: Primary vs secondary law states	Front seat motor vehicle occupants in U.S. 50 states	Fatalities	NA	Percent change in rate of fatalities (difference between primary and secondary law states): -7.7% (p=0.0001)	-7.7%	0-10 years

Appendix Continued

Author, Year Study period Design suitability (design) Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Effect measure	Reported baseline	Reported effect	Value used in summary[a]	Follow-up time[b]
Houston 1995 [4] 1967-1991 Greatest (time series with concurrent comparison) Fair 50 U.S. states	Age: All Position: Front Vehicles: Not stated Fines: Not stated Effective Dates: Varied Comparison: Primary vs secondary law states	All motor vehicle occupants in U.S. 50 states	Fatalities per billion vehicle miles traveled (bVMT)	NA	Change in number of fatalities per bVMT: Primary laws: -3.616 (p<.001), or 3.616 fewer deaths per bVMT compared with no law Secondary laws: -4.252 (p<.001), or 4.252 fewer deaths per bVMT compared with no law	NA[c]	0-7 years
Houston 1996 [5] 1975-1991 Greatest (time series with concurrent comparison) Fair 50 U.S. states	Age: All Position: Front Vehicles: Not stated Fines: Not stated Effective Dates: Varied Comparison: Primary vs secondary law states	All motor vehicle occupants in U.S. 50 states	Fatalities per bVMT	NA	Change in number of fatalities per bVMT: Primary laws: -0.639 (p<.001), or 0.6388 fewer deaths per bVMT compared with no law Secondary laws: -0.002 (N.S.), or .0023 fewer deaths per bVMT compared with no law	NA[c]	0-7 years

[a] Percent change
[b] Period following passage of primary enforcement law
[c] Percent change could not be calculated from the data provided

Abbreviations: bVMT, billion vehicle miles traveled; VMT, vehicle miles traveled

References

1. Wagenaar AC, Maybee RG, Sullivan KP. Mandatory seat belt laws in eight states: a time-series evaluation. Journal of Safety Research 1988;19:51-70.

2. Evans WN, Graham JD. Risk reduction or risk compensation? The case of mandatory safety-belt use laws. Journal of Risk and Uncertainty 1991;4:61-73.

3. Winnicki J. Safety belt use laws: evaluation of primary enforcement and other provisions. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1995. DOT HS 808 324.

4. Houston DJ, Richardson LE, Neeley GW. Legislating traffic safety: A pooled time series analysis. Social Science Quarterly 1995;76:328-45.

5. Houston DJ, Richardson LE, Neeley GW. Mandatory seat belt laws in the states: a study of fatal and severe occupant injuries. Eval Rev 1996;20:146-59.

Appendix 2: Studies Measuring the Incremental Effect of Primary Enforcement Laws Relative to Secondary Enforcement Laws on Safety Belt Use

Author, Year Study period Design suitability (design) Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Effect measure	Reported baseline	Reported effect	Value used in summary[a]	Follow-up time[b]
Campbell 1988 [1] 1985-1987 Least (cross-sectional) Fair 20 U.S. states (Primary: CT, HI, IL, IA, NM, NY, NC, TX; Secondary: CA, ID, LA, MD, MA, MI, NE, NJ, OH, UT, WA, and Washington, DC)	Age: All Position: Front Vehicles: Passenger Fines: Varied Effective Dates: Varied Comparison: Primary vs secondary law states	Front seat motor vehicle occupants in 20 U.S. states 20 states	Observed safety belt use	NA	Primary States: Intercept = 44.5% belt use (p<.01) Secondary States: Intercept = 31.9% belt use (p<.01)	+12.6%	NA
Ulmer 1995 [2] 1986-1993 Moderate (time series) Fair Six communities in California (Bakersfield, Fresno, Monterey, Riverside, Salinas, San Bernardino)	Age: All Position: Front Vehicles: Passenger cars (taxi, 6000+ lb trucks, police, postal exempt) Fines: $20-$50 Law went into effect: 1-1-93 Comparison: Change from secondary to primary enforcement within same state	Drivers in six communities in California Not reported	Observed safety belt use	Secondary Law: 58.0%	Primary Law: 76.2%	+18.2%	7 months
Preusser 1997 [3] 1992-1996 Moderate (time series) Fair Five communities in Louisiana (Baton Rouge, Lake Charles, Monroe, Shreveport, St. Tammany Parish)	Age: All Position: Front Vehicles: Passenger cars, light trucks, vans Fines: $25-$50 Effective Date: 11-1-95 Comparison: Change from secondary to primary enforcement within same state	Front seat motor vehicle occupants in five communities in Louisiana N = 45,662 observations	Observed safety belt use	Secondary Law: 51.9%	Primary Law: 66.0%	+14.1%	6 months

Appendix Continued

Author, Year Study period Design suitability (design) Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Effect measure	Reported baseline	Reported effect	Value used in summary[a]	Follow-up time[b]
Lange 1998 [4] 1991-1995 Moderate (time series) Fair Two communities in California (Oceanside, Salinas)	Age: All Position: Front Vehicles: Not stated Fines: Not stated Law went into effect: 1-1-93 Comparison: Change from secondary to primary enforcement within same state	Drivers in California N=18,469	Observed safety belt use	Secondary Law (95% CI): 73.0% (71.9, 74.1)	Primary Law (95% CI): 95.6% (95.2, 96.0)	+22.6%	2.5 years
Solomon 2000 [5] 1993-1998 Moderate (time series) Fair MD, OK, Washington, DC	Age: All Position: Front Vehicles: Varied Fines: MD $25 unchanged; OK lowered to $20; DC increased to $50 + 2 points on license. Law went into effect: MD 10-1-97 OK 11-1-97 DC 10-9-97 Comparison: Change from secondary to primary enforcement within same state	Front seat motor vehicle occupants N=3707 (OK) N=4945 (MD) N=unknown (DC)	Observed safety belt use	Secondary Law: MD 71% OK 47% DC 66%	Primary Law: MD 83% OK 56% DC 80%	+12%	9-10 months
Winnicki 1995 [6] 1983-1994 Greatest (time series with concurrent comparison) Fair 50 U.S. states	Age: All Position: Front Vehicles: Varied Fines: Varied Law went into effect: Various dates Comparison: Primary vs secondary law states	Fatally injured occupants of motor vehicle crashes in U.S. 50 states	Police-reported safety belt use	NA	Incremental increase in safety belt use in primary vs secondary law states (percent change estimated from regression model) 14.4% (p=0.0001)	NA[c]	0-10 years

Appendix Continued

Author, Year Study period Design suitability (design) Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Effect measure	Reported baseline	Reported effect	Value used in summary[a]	Follow-up time[b]
Fielding 1992 [7] 1988-1989 Least (cross-sectional) Fair 50 U.S. states	Age: All Position: Front Vehicles: Not stated Fines: Not stated Law went into effect: Various dates Comparison: Primary vs secondary law states	Volunteer health profile participants in U.S. whose employers belonged to Johnson and Johnson Health Management N=17,830	Self-reported safety belt use	NA	Primary Law: 78% Secondary Law: 77%	+1%	NA
Escobedo 1992 [8] 1984-1989 Greatest (time series with concurrent comparison) Fair 12 U.S. states (Primary: NC; Secondary: CA, ID, IL, IN, MN, MO, OH, SC, TN, UT, WI)	Age: All Position: Front Vehicles: Not stated Fines: Not stated Law went into effect: NC 10-85 Comparison: Primary vs secondary law states	U.S. residents age 18 and over with telephones N=~100,000	Self-reported safety belt use	Primary Law pre: 21% Secondary Law pre: 22%	Behavioral Risk Factor Surveillance System (BRFSS) "Always use": Primary Law post: 70% Secondary Law post: 49%	+22%	3 years

[a] Percentage point difference
[b] Period following passage of primary enforcement law.
[c] Percent change could not be calculated from the data provided

References

1. Campbell BJ. The association between enforcement and seat belt use. Journal of Safety Research 1988;19:150-63.
2. Ulmer RG, Preusser CW, Preusser DF, Cosgrove LA. Evaluation of California's safety belt law change from secondary to primary enforcement. Journal of Safety Research 1995;26:213-20.
3. Preusser DF, Preusser CW. Evaluation of Louisiana's safety belt law change to primary enforcement. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1997. DOT HS 808 620.
4. Lange JE, Voas RB. Nighttime observations of safety belt use: an evaluation of California's primary law. Am J Public Health 1998;88:1718-20.
5. Solomon MG, Nissen WJ. Evaluation of Maryland, Oklahoma, and the District of Columbia's seat belt law change to primary enforcement. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 213.
6. Winnicki J. Safety belt use laws: evaluation of primary enforcement and other provisions. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1995. DOT HS 808 324.
7. Fielding JE, Knight KK, Goetzel RZ. The impact of legislation on self-reported safety belt use in a working population. J Occup Med 1992;34:715-7.
8. Escobedo LG, Chorba TL, Remington PL, Anda RF, Sanderson L, Zaidi AA. The influence of safety belt laws on self-reported safety belt use in the United States. Accid Anal Prev 1992;24:643-53.

Reviews of Evidence Regarding Interventions to Reduce Alcohol-Impaired Driving

Ruth A. Shults, PhD, MPH, Randy W. Elder, MEd, David A. Sleet, PhD, MA, James L. Nichols, PhD, Mary O. Alao, MA, Vilma G. Carande-Kulis, PhD, MS, Stephanie Zaza, MD, MPH, Daniel M. Sosin, MD, MPH, Robert S. Thompson, MD, and the Task Force on Community Preventive Services

Background: Alcohol-related motor vehicle crashes are a major public health problem, resulting in 15,786 deaths and more than 300,000 injuries in 1999. This report presents the results of systematic reviews of the effectiveness and economic efficiency of selected population-based interventions to reduce alcohol-impaired driving.

Methods: The *Guide to Community Preventive Services*'s methods for systematic reviews were used to evaluate the effectiveness of five interventions to decrease alcohol-impaired driving, using changes in alcohol-related crashes as the primary outcome measure.

Results: Strong evidence was found for the effectiveness of .08 blood alcohol concentration laws, minimum legal drinking age laws, and sobriety checkpoints. Sufficient evidence was found for the effectiveness of lower blood alcohol concentration laws for young and inexperienced drivers and of intervention training programs for servers of alcoholic beverages. Additional information is provided about the applicability, other effects, and barriers to implementation of these interventions.

Conclusion: These reviews form the basis of the recommendations by the Task Force on Community Preventive Services presented elsewhere in this supplement. They can help decision makers identify and implement effective interventions that fit within an overall strategy to prevent impaired driving.

Medical Subject Headings (MeSH): community health services; decision making; evidence-based medicine; practice guidelines; preventive health services; public health practice; meta-analysis; review literature; motor vehicles; seat belts; accidents, traffic; accident prevention; automobile driving; alcohol drinking; wounds and injuries (Am J Prev Med 2001;21(4S):66–88)

Introduction

The United States has made substantial progress in reducing alcohol-related traffic fatalities in recent decades. Since the National Highway Traffic Safety Administration (NHTSA) began keeping records on alcohol involvement in fatal crashes in 1982, the proportion of all traffic fatalities that are alcohol-related has declined steadily from 57% to 38%.[1] Despite this progress, alcohol-related motor vehicle crashes continue to be a major public health problem, resulting in 15,786 deaths and more than 300,000 injuries in 1999.[1]

Since 1970, individual states and communities have implemented a broad range of strategies to reduce alcohol-impaired driving. Laws to deter alcohol-impaired driving and to control the sale or public consumption of alcohol are among the most widely used strategies. By 1987, all states had enacted a minimum legal drinking age of 21 years. As of May 1, 2001, a total of 24 states, the District of Columbia, and Puerto Rico had lowered the illegal blood alcohol concentration (BAC) for drivers aged 21 years and older from 0.10 g/dL to 0.08 g/dL. Community-based interventions, including sobriety checkpoints, enhanced enforcement of alcohol control policies, and training programs for servers of alcoholic beverages, have also been implemented in some states.

From the Division of Unintentional Injury Prevention (Shults, Elder, Sleet) and Office of the Director (Sosin), National Center for Injury Prevention and Control, and Division of Prevention Research and Analytic Methods, Epidemiology Program Office (Carande-Kulis, Alao, Zaza), Centers for Disease Control and Prevention, Atlanta, Georgia; Office of Research and Traffic Records, National Highway Traffic Safety Administration (Nichols), Washington, DC; Task Force on Community Preventive Services and The Department of Preventive Care, Group Health Cooperative of Puget Sound (Thompson), Seattle, Washington

The research described in this article was awarded the Department of Health and Human Services Secretary's Award for Distinguished Service.

Address correspondence and reprint requests to: Ruth A. Shults, PhD, MPH, Division of Unintentional Injury Prevention, Centers for Disease Control and Prevention, 4770 Buford Highway, Mailstop K-63, Atlanta, GA 30341. E-mail: ras1@cdc.gov.

0749-3797/01/$–see front matter
PII S0749-3797(01)00381-6

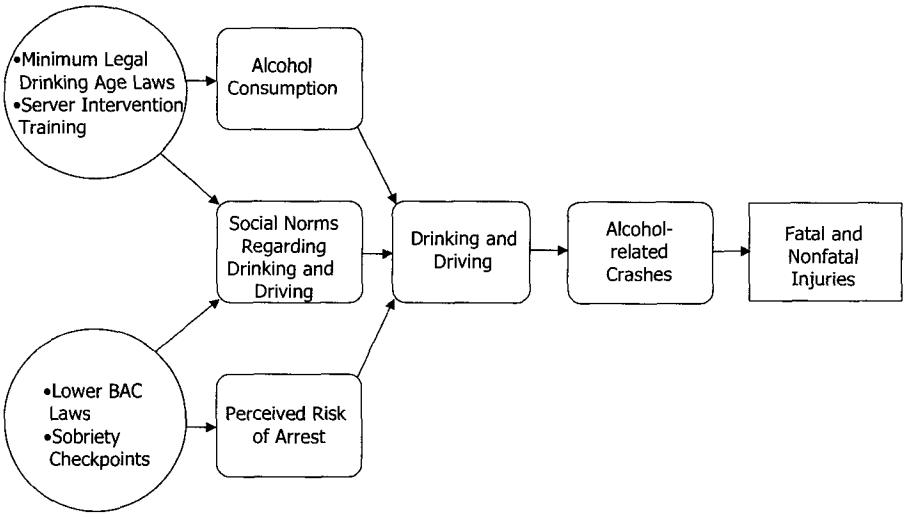


Figure 1. Logic framework for reviews of interventions to reduce alcohol-impaired driving.
BAC, blood alcohol concentration.

Data provided by NHTSA and the U.S. Bureau of the Census in 1999 indicate that the United States nearly met the *Healthy People 2000* objective for alcohol-related motor vehicle deaths of no more than 5.5 deaths per 100,000 persons, with a rate of 5.8 per 100,000 persons.[1–3] The *Healthy People 2010*[4] target for alcohol-related motor vehicle fatalities is 4.0 per 100,000 persons or fewer. Meeting the 2010 objective will require a further decrease of 31% in the rate of alcohol-related motor vehicle fatalities. The recommendations of the Task Force on Community Preventive Services (the Task Force)[5] are intended to help communities, working with public health and traffic safety professionals, identify and implement effective programs and policies.

Some of the laws evaluated in the systematic review have already been widely enacted in the United States. Information about the effectiveness of these laws will be useful in evaluating any future proposals to repeal or to revise them. In addition, the systematic review highlights important unanswered questions about the effectiveness of these laws in various settings (e.g., urban vs rural).

Conceptual Approach

This systematic review was undertaken to assess the effectiveness of a number of laws and other community-based interventions in reducing alcohol-impaired driving and alcohol-related motor vehicle crash fatalities in the United States and other Established Market Economies.[a] Of the 76 studies included in the review, 55 (72%) were conducted in the United States. Other studies were conducted in Australia, Canada, New Zealand, France, and The Netherlands.

We focused on interventions for which the primary goal was to reduce alcohol-impaired driving. We did not review interventions intended primarily to restrict access to alcohol (e.g., alcohol taxation, alcohol outlet zoning restrictions) or to address health outcomes of alcohol abuse or misuse other than alcohol-impaired driving. Those topics will be included in the Task Force's review of interventions to prevent alcohol abuse and misuse as part of the *Guide to Community Preventive Services* (the *Community Guide*).

The logic framework shown in Figure 1 depicts the conceptual approach that guided the review process. This figure illustrates the hypothesized links between interventions to reduce alcohol-impaired driving and the outcomes of interest. These interventions are thought to work through three separate pathways: They may reduce alcohol-impaired driving by increasing the perceived risk of detection and punishment; They may reduce alcohol consumption in high-risk settings or among high-risk groups; and they may foster a social norm that reduces the acceptable amount of alcohol to consume before driving.

Methods

The *Community Guide*'s methods for systematic reviews and for linking evidence to recommendations have been published elsewhere.[6] An overview of the general methods used in the systematic reviews of interventions to reduce motor vehicle occupant injury appears in the supplement.[7] This discussion is limited to topics that apply specifically to interventions to reduce alcohol-impaired driving.

[a]Established Market Economies as defined by the World Bank are Andorra, Australia, Austria, Belgium, Bermuda, Canada, Channel Islands, Denmark, Faeroe Islands, Finland, France, Former Federal Republic of Germany, Germany, Gibraltar, Greece, Greenland, Holy See, Iceland, Ireland, Isle of Man, Italy, Japan, Liechtenstein, Luxembourg, Monaco, The Netherlands, New Zealand, Norway, Portugal, San Marino, Spain, St. Pierre and Miquelon, Sweden, Switzerland, the United Kingdom, and the United States.

Table 1. Priority interventions selected for review

	Interventions
Laws & Policies	**.08 blood alcohol concentration (BAC) laws**
	Lower BAC laws for young and inexperienced drivers
	Minimum legal drinking age laws
	Administrative license revocation
	Ignition interlocks
Law Enforcement	**Sobriety checkpoints**
Behavioral	**Intervention training programs for servers of alcoholic beverages**
	Alternative transportation (e.g., designated driver programs)
	Assessment and treatment for DUI offenders
Provision of Information	*Mass media campaigns*
	School-based education
Multifaceted Programs	*Multifaceted community-based programs*

Italics indicate interventions not yet reviewed.
DUI, driving under the influence of alcohol.

Selecting Interventions

The consultation team (see Acknowledgments) generated a comprehensive list of interventions to reduce alcohol-impaired driving and created a priority list of interventions to be reviewed after surveying consultants and other experts. Those individuals were asked to rank interventions as priorities for systematic review, considering whether each intervention is (1) thought to be effective but underused; (2) thought to be ineffective but overused; (3) popular, but its effectiveness is not well established; (4) costly, but its effectiveness is not well established; (5) targeted to a specific population of interest (e.g., youth); or (6) broad reaching, and could achieve large reductions in alcohol-impaired driving if found to be effective. Rankings were compiled, and the 12 interventions with the most votes were selected as priorities for this review (Table 1). Resource limitations prevented us from completing reviews of all of the priority interventions in time for this publication. Additional reviews will be published as they are completed.

Selecting Summary Effect Measures

The primary outcomes assessed in this literature are fatal and nonfatal injuries resulting from alcohol-related motor vehicle crashes. This information is primarily derived from police incident reports. In the United States, information about all fatal crashes that occur on public roads is available in electronic form through NHTSA's Fatality Analysis Reporting System (FARS).[8] There is no comparable single source of electronic information about all nonfatal crashes. Of the 69 studies that examined crash data, 35 (51%) examined only fatal crashes.

Differences in how "alcohol-relatedness" of crashes is operationally defined from study to study contribute to the variability in the effect measures in this review. Until recent decades, the BACs of drivers involved in fatal crashes were measured too sporadically to be useful in evaluating interventions to reduce alcohol-impaired driving. Objective measures of alcohol involvement in nonfatal crashes continue to be collected only sporadically. Given the limited availability of BAC data, many studies have used proxy variables for alcohol-related crashes. Commonly used proxy variables, and their estimated level of association with alcohol involvement, are listed in Table 2. Using proxy variables for alcohol involvement produces effect estimates that are biased toward the null, with the degree of bias being more pronounced for proxies with weaker association with alcohol involvement.

Important differences exist in the operational definitions of "alcohol-relatedness" of crashes even among studies that use driver BAC data. For fatal crashes in the United States, the FARS system uses a statistical model to estimate the BAC of drivers for whom BACs were not obtained.[9] Some of the studies in this review used the estimated values for BAC

Table 2. Estimated probability of alcohol involvement for various crash types in the United States, 1999

Crash type[a]	Estimated probability of alcohol involvement[b] (%)
Proxies for alcohol-involved crashes	
Nighttime single-vehicle fatal crashes (6:00 PM to 5:59 AM)	64
Nighttime fatal crashes (6:00 PM to 5:59 AM)	60
All fatal crashes	38
Late night single-vehicle nonfatal injury crashes (12:00 AM to 5:59 AM)	41
Late night nonfatal injury crashes (12:00 AM to 5:59 AM)	37
Late night property damage only crashes (12:00 AM to 5:59 AM)	23
Comparison crash types	
Daytime fatal crashes (6:00 AM to 5:59 PM)	17
Daytime nonfatal injury crashes (6:00 AM to 5:59 PM)	4

[a]The categories of crash types are provided for descriptive purposes. In most studies reviewed, crashes that met or exceeded a given level of severity were combined.
[b]Alcohol involvement is defined by a measured or estimated blood alcohol concentration (BAC) of 0.01 g/dL or greater for fatal crashes and by police report for nonfatal crashes.
Source: National Highway Traffic Safety Administration.[1]

provided by the FARS statistical model. Other studies considered as alcohol-related only those crashes involving drivers with measured BACs above an established level. Additionally, studies defined alcohol-relatedness using various BAC cutpoints (i.e., ≥0.01 g/dL, ≥0.08 g/dL, or ≥0.10 g/dL).

We often had to select from several possible effect measures. We established and consistently applied rules for identifying the outcome measure that most adequately reflected alcohol-related crashes and addressed potential confounding variables. Briefly, we considered BAC data to be the most objective measure of alcohol-relatedness of crashes. For studies that reported results using more than one cutpoint for BAC, we chose the results based on the BAC cutpoint closest to 0.10 g/dL.

When available, we selected effect measures that compared alcohol-related fatalities with non–alcohol-related fatalities (e.g., proportion of all fatal crashes involving drivers with BACs of ≥0.10 g/dL; ratio of single-vehicle nighttime fatal crashes to multi-vehicle daytime fatal crashes) over the absolute number of alcohol-related fatalities. These effect measures help control for both the long-term downward trend in total fatal crashes and factors that influence the total number of crashes, such as weather, economic conditions, vehicle miles traveled, and safety characteristics of vehicles and highways.[10] When available, we also selected effect measures that incorporated a concurrent comparison group such as drivers in adjacent states or drivers within the same state who were unaffected by the intervention. For those studies, results were reported in the form of the net change, reflecting the difference between the percent change for the intervention group and the comparison group. Net change was calculated by using the formula

$$(I_{post} - I_{pre})/I_{pre} - (C_{post} - C_{pre})/C_{pre}$$

where:

I refers to the group exposed to the intervention,
C refers to the group not exposed to the intervention (the comparison group),
post refers to outcome measurements after implementation of the intervention, and
pre refers to outcome measurements before implementation of the intervention.

For studies using interrupted time series or other regression-based analyses, results were reported in terms of the percent change estimated from the model.

The other outcomes assessed in this review were BACs of drivers at roadside surveys, as well as measured and estimated BACs of people leaving bars or other licensed establishments. Net changes in these outcomes were calculated by using the same formula as for the crash outcomes.

Effect measures from individual studies are displayed in figures, and a median effect measure and range for each outcome of interest is reported. For median effect measures based on seven or more studies, the interquartile range is reported. For interventions with a large number of studies, we also evaluated whether the intervention's effect varied by follow-up time.

Table 3. .08 BAC laws: descriptive information about included studies

	Number of studies
Papers meeting inclusion criteria	9[10–18]
Papers excluded, limited execution quality	0
Qualifying papers	9[10–18]
Study designs	
Time series with concurrent comparison group	2[11,18]
Time series, no concurrent comparison group	2[15,16]
Before–after with concurrent comparison group	5[10,12–14,17]
Outcomes reported	
Fatal injury crashes	8[10–15,17,18]
Fatal and nonfatal injury crashes	1[16]

BAC, blood alcohol concentration.

Intervention Effectiveness and Economic Efficiency .08 BAC Laws

In the United States, states have two basic types of alcohol-impaired driving laws. The first type prohibits a person from driving while intoxicated (DWI). Originally, these laws did not require evidence of a specific BAC. The second type of law, which came later, made it illegal "per se" to operate a motor vehicle at or above a specified BAC. These laws, referred to as per se laws, were usually enacted in addition to the existing DWI laws. Originally, most per se laws specified a BAC of 0.10 g/dL or 0.15 g/dL as being illegal. In 1983, Utah and Oregon lowered the illegal BAC from 0.10 g/dL to 0.08 g/dL. By May 1, 2001, a total of 24 states, the District of Columbia, and Puerto Rico had enacted laws lowering the illegal BAC to 0.08 g/dL. These laws, referred to as .08 BAC laws, are the subject of this review.

In the United States, per se laws apply to all drivers, but they target primarily drivers aged 21 years and older. This target is because, as of July 1998, all states had enacted per se laws for drivers aged 20 years and younger that establish BAC limits of 0.02 g/dL or less.

Reviews of evidence

Effectiveness. The evidence base for .08 BAC laws included published journal articles, technical reports, and conference papers. Our search identified nine studies, all of which were of sufficient design quality and execution to be included in the review.[10–18] Descriptive information about the quality, study design, and outcome measures from these studies is presented in Table 3. Details of the nine qualifying studies are provided in the Appendix and at the website (www.thecommunityguide.org).

All nine studies analyzed data from police incident reports of crashes occurring on public roadways. Post-law follow-up times for individual state laws ranged from 1 to 14 years (median, 5).

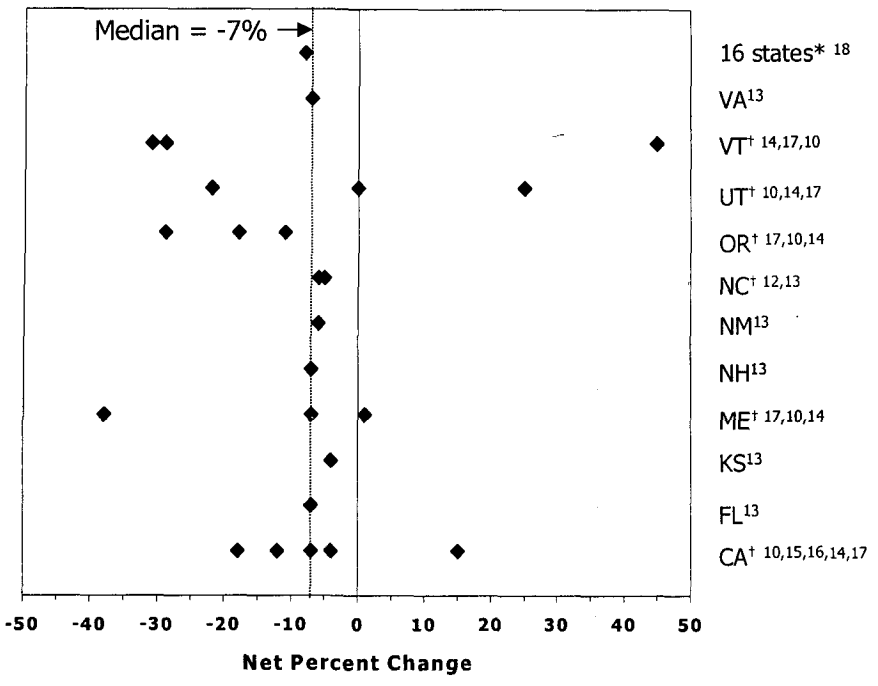


Figure 2. Percent change in measures of alcohol-related motor vehicle fatalities after .08 BAC laws were enacted, by state. *Numbers correspond to reference numbers of cited studies. †Median percent change calculated by using the median value for the state.

Eight of the nine studies reported the percent change in alcohol-related fatalities (post-law period vs pre-law period) or provided the data needed to calculate the measure.[10,12–18] Seven studies provided state-specific percent change values, and the remaining study provided a summary percent change value for all 16 states that enacted .08 BAC laws before January 1, 1998 (Figure 2). The median post-law percent change in alcohol-related motor vehicle fatalities was −7% (interquartile range, −15% to −4%). Results were generally consistent in direction and size across the studies.

One study reported a 45% net increase (95% confidence interval [CI], −13% to +144%) in fatalities after enactment of the .08 BAC law in Vermont.[10] This study compared alcohol-related fatalities in Vermont with those in New Hampshire. The result of this comparison is imprecise because there were fewer than 100 alcohol-related motor vehicle fatalities in each state during the 3-year study period.

Evaluations of .08 BAC laws in the states of California, Maine, Oregon, Utah, and Vermont[10,11,14–17] were limited in their ability to separate the effect of .08 BAC laws from that of administrative license revocation (ALR) laws, which were enacted at about the same time. ALR laws allow the arresting officer, judge, or magistrate to seize the license of a driver who refuses or fails a BAC test. Two recently published studies provide summary estimates of the effect of .08 BAC laws independent of ALR laws. In a secondary analysis, Hingson et al.[13] reported an overall post-law decline in alcohol-related fatal crashes of 5% in four states that had long-standing ALR laws. Voas et al.[18] estimated the separate effects of BAC laws and ALR laws by using multivariate regression analysis. They reported an 8% decline in fatally injured alcohol-impaired drivers attributable to .08 BAC laws.

Applicability. The states represented in the evidence base are geographically diverse with varying population densities. Because all of the studies analyzed data from statewide police incident reports of fatal crashes, the evidence of effectiveness should be applicable to all drivers affected by .08 BAC laws. None of the studies, however, provided data to assess differences in effectiveness for various subgroups of the driving population.

In support of .08 BAC laws, the U.S. Congress included a provision in the Fiscal Year 2001 Department of Transportation and Related Agencies Appropriations Act[19] that requires states to implement .08 BAC laws by October 2003 or risk losing federal highway construction funds.

Other positive or negative effects. Three studies measured outcomes other than motor vehicle crashes, including public knowledge and perception of impaired driving laws, self-reported impaired driving, and impaired driving arrests.[12,15,16] Information about these other potential effects was not summarized in this review.

Table 4. Lower BAC laws for young or inexperienced drivers: descriptive information about included studies

	Number of studies
Papers meeting inclusion criteria	11[22–32]
Papers reporting on more than one study	2[25,27]
Actual number of studies meeting inclusion criteria	16
Papers excluded, limited execution quality	3[25,27,28]
Actual number of studies excluded	8
Qualifying papers	8[22–24,26,29–32]
Papers reporting additional information on already-included studies	2[31,32]
Actual number of qualifying studies	6
Study designs	
Time series with concurrent comparison group	3[24,29,30]
Time series, no concurrent comparison group	1[23]
Before–after with concurrent comparison group	2[22,26]
Outcomes reported	
Fatal injury crashes	3[22,29,30]
Fatal and nonfatal injury crashes	2[24,26]
"Had been drinking" crashes	1[23]

BAC, blood alcohol concentration.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[7]

Barriers to intervention implementation. One potential barrier to implementation of .08 BAC laws is the view that the laws discourage "social drinkers" from driving after drinking small amounts of alcohol but do not deter "hard-core" drinking drivers. Results of the systematic review provide some evidence to counter this view. Five of the nine studies measured fatalities involving drivers with BACs of 0.10 g/dL or higher, and these studies reported post-law reductions for most states.[11–14,18]

Conclusion. According to the *Community Guide*'s rules of evidence, available studies provide strong evidence that .08 BAC laws are effective in reducing alcohol-related crash fatalities.

Lower BAC Laws for Young or Inexperienced Drivers

Lower BAC laws for young or inexperienced drivers establish a lower illegal BAC for these drivers than for older or more experienced drivers. Although these laws are commonly referred to as "zero tolerance" laws, in many jurisdictions the BAC limit for affected drivers is slightly above zero (e.g., 0.02 g/dL).

Young people who drive after drinking alcohol pose an inordinate risk to themselves, their passengers, and other road users. A recent U.S. study[20] estimated that male drivers aged 16 to 20 years with BACs in the range of 0.08 to <0.10 g/dL were 24 times more likely to die in a motor vehicle crash than those with BACs of zero.

In the United States, lower BAC laws have typically applied to all drivers younger than the minimum legal drinking age of 21 years. In Austria, Australia, New Zealand, and some Canadian provinces, lower BAC laws apply either to all newly licensed drivers or to newly licensed drivers younger than a specified age.[21] The first U.S. laws lowering the illegal BAC for underage drivers were enacted in 1983 in Maine and North Carolina. By December 1994, 27 states and the District of Columbia had enacted lower BAC laws, with BAC limits ranging from any detectable level of BAC to 0.07 g/dL.[22] In support of lower BAC laws, the U.S. Congress included a provision in the National Highway Systems Designation Act of 1995 that required states to implement a BAC limit of 0.02 g/dL or less for all drivers younger than the age of 21 years by October 1998 or risk losing federal highway construction funds. By July 1998, all 50 states had enacted lower BAC laws.

Reviews of evidence

Effectiveness. The evidence base for this intervention included published journal articles, technical reports, and conference proceedings. We found nine publications[22–30] that reported on 14 separate studies of the effectiveness of lower BAC laws. Two additional papers provided more information about an already-included study.[31,32] Descriptive information about the quality, study design, and outcome measures from these studies is presented in Table 4. Details of the six qualifying studies are provided at the website (www.thecommunityguide.org).

Four of the six studies were conducted in the United States,[22,23,29,30] and the remaining two were conducted in Australia.[24,26] Two of the U.S. studies evaluated lower BAC laws in multiple states.[22,30] All six studies analyzed data from police incident reports of motor vehicle crashes occurring on public roadways. Post-law follow-up times for individual state laws ranged from less than 1 year to 15 years. The median post-law follow-up time for the six studies was 22 months.

Each of the six studies reported a post-law reduction

in crashes. The three studies that examined fatal crash outcomes reported declines of 24%,[30] 17%,[22] and 9%.[29] The two studies that examined fatal and nonfatal injury crashes reported declines of 17%[26] and 3.8%.[24] The study that examined crashes in which the investigating police officer believed that the driver had been drinking alcohol reported a decline of 11%.[23]

Applicability. The same body of evidence used to assess effectiveness was used to assess the applicability of these interventions in various settings. The states studied are geographically diverse and have both urban and rural populations. Because all of the studies analyzed data from the statewide files of police-reported crashes, the evidence of effectiveness should be applicable to all drivers affected by these lower BAC laws. None of the studies, however, provided data to assess differences in effectiveness for various subgroups of the affected population.

Lower BAC laws have been enacted for other defined populations not addressed in this review, including commercial truck drivers and people convicted of driving while impaired. The Centers for Disease Control and Prevention has recommended that states consider enacting lower BAC laws for all drivers who transport children.[33]

Other positive or negative effects. It is possible that drivers younger than the age of 21 years with high BACs could receive "zero tolerance" citations for violating the lower BAC law, whereas adults with the same BAC would be arrested for the more serious offense of driving under the influence of alcohol (DUI). Voas et al.[29] explored this potential negative effect in an evaluation of California's 1994 lower BAC law. They reported that the combined rate of alcohol-related license suspensions for zero tolerance citations and DUI arrests among underage drivers increased only slightly after enactment of the 1994 lower BAC law. Furthermore, 57% of underage drivers who received zero tolerance citations had BACs above 0.08 g/dL. The investigators concluded that California's 1994 lower BAC law resulted in about half of the potential DUI arrests among underage drivers being converted to less serious zero tolerance citations.

Economic. One study[34] met the criteria for inclusion[6,7] in the review of lower BAC laws for young or inexperienced drivers. The study applied previously published crash costs and used effectiveness data from other previously published studies to illustrate how these costs could be applied to lower BAC laws in the United States. The benefits from a reduction in alcohol-related crashes were estimated on the basis of the assumption that lower BAC laws reduce young drivers' alcohol-related crashes by 20%. Monetary benefits and costs were reported in dollars per mile driven.

The study conducted a cost–benefit analysis. The estimated benefit-to-cost ratio[b] for lower BAC laws was $11 per dollar invested when violators receive a 6-month license suspension. Costs included the cost of trials and sanctions imposed and compliance costs to young drivers (i.e., cost of the loss of mobility).

The study was classified as satisfactory, based on the quality assessment criteria for economic evaluations used in the *Community Guide*.[7,35] Study details, adjusted results, and quality scoring are provided in the economic evaluation summary tables at the website (www.thecommunityguide.org).

Barriers to intervention implementation. All U.S. states currently have lower BAC laws for drivers younger than age 21 years. Voas et al.[29] discussed several potential barriers to full enforcement of these laws. Because young people are less likely than adults to drink in bars, police patrols that target bar neighborhoods are likely to miss underage drinking drivers. Also, officers may have difficulty identifying underage drinking drivers with low BACs who do not show signs of impairment. Finally, because of ambiguities, some state laws do not authorize officers to test the BAC of an underage driver unless the officer has probable cause to believe that the driver's BAC is above the legal limit for adults.

Conclusion. According to the *Community Guide*'s rules of evidence, there is sufficient evidence that lower BAC laws are effective in reducing alcohol-related crashes among young or inexperienced drivers.

Minimum Legal Drinking Age Laws

Minimum legal drinking age (MLDA) laws specify an age below which the purchase or public consumption of alcoholic beverages is illegal. Studies included in this review assessed the effect of raising or lowering the MLDA on crashes and related fatal and nonfatal injury outcomes.

In the United States, several states lowered their MLDA during the early 1970s. Shortly thereafter, in response to an increase in motor vehicle fatalities among young people, some of these states raised their MLDA. To address continuing concerns about youth drinking and driving, federal legislation requiring states to adopt a minimum drinking age of 21 years or lose highway funds was passed in 1984. By 1987, all U.S. states had adopted an MLDA of 21.

Reviews of evidence

Effectiveness. The evidence base for this intervention included only published journal articles. We reviewed three bodies of evidence that evaluated the effect of MLDA changes: studies of the effect of raising the

[b]A benefit-to-cost ratio is provided as a stand-alone piece of information and should not be used to rank interventions unless (1) there is a known budget constraint, (2) the interventions are mutually independent, or (3) interventions exhibit constant returns to scale.

Table 5. Minumum legal drinking age laws: descriptive information about included studies

	Number of studies
Papers meeting inclusion criteria	46[30,36–80]
Papers excluded, limited execution quality	13[38,49,57,59,62–64,69–72,76,77]
Qualifying papers	33[30,36,37,39–48,50–56,58,60,61,65–68,73–75,78–80]
Papers reporting additional information on already-included studies	3[78–80]
Actual number of qualifying studies[a]	33[30,36,37,39–48,50–56,58,60,61,65–68,73–75]
Study designs	
Time series with concurrent comparison group	16[30,36,40,42,48,52,53,55,61,65–68,73–75]
Time series, no concurrent comparison group	2[39,50]
Before–after with concurrent comparison group	15[37,41,43–47,51,54,56,58,60]
Outcomes reported	
Fatal injury crashes or crash fatalities	22[30,36,37,39,41,43–47,50,53–55,61,65–68,73–75]
Fatal and nonfatal injury crashes	8[42,48,51,52,60]
Other crash types	4[40,52,56,58]

[a]Four studies from a single paper[60] qualified for review.

MLDA, studies of the effect of lowering the MLDA, and studies that used multiple regression to evaluate the effect of MLDA changes. The regression-based studies are reported separately because they cover all U.S. states during overlapping time periods, and their results are not independent of each other. Most studies in the review assessed the effect of changes in the MLDA from 18 to 21 years or vice versa. Outcomes were typically assessed in the age groups affected by the law change.

Forty-nine studies reported in 46 papers met the inclusion criteria for this review: 17 studies of the effect of raising the MLDA,[36–52] 11 studies of the effect of lowering the MLDA contained in eight reports,[53–60] and 18 regression-based studies of the effect of changing the MLDA.[30,61–77] Three papers provided additional information about already-included studies.[78–80] Descriptive information about the quality, study design, and outcome measures from all MLDA studies is presented in Table 5. The effects of changes in the MLDA on crash outcomes likely to involve alcohol are summarized in Table 6. Details of the 33 qualifying studies are provided at the website (www.thecommunityguide.org).

Figure 3 presents the findings from the evidence base, aggregated across all crash outcomes. These results suggest that changes in the MLDA result in changes of roughly 10% to 16% in alcohol-related crash outcomes for the targeted age groups, decreasing when the MLDA is raised, and increasing when it is lowered. These effects were consistent over follow-up times ranging from 7 to 108 months.

In some studies, the age group directly affected by the change in the MLDA was not identical to the age group on which outcomes were evaluated. These discrepancies usually arose when crash data pertaining only to the affected age group were not available, or when young people who were of legal drinking age before the law change were allowed to continue to purchase or consume alcohol (i.e., were grandfathered). For 15 studies with perfect overlap between the age group targeted by the law and the age group analyzed,[30,40–43,45,46,48,51–55,58,67] the median change in crashes was 19%. For 17 studies (in 14 reports) with misclassification into the outcome group of subjects not affected by the MLDA change,[36,37,39,44,50,56,60,61,65,66,68,73–75] the median change was only 12%.

Table 6. Effects of changing the mimiumum legal drinking age: summary effects from the body of evidence on crash outcomes likely to involve alcohol

Outcome	Number of studies	Median change	Range[a]
Raising the MLDA			
Fatal injury crashes[b]	9[36,37,39,41,43–46,50]	17% decrease	30%–7% decrease
Fatal and nonfatal injury crashes	4[42,48,51,52]	15% decrease	33%–6% decrease
Other crashes	2[40,52]	NA	21% and 18% decrease
Lowering the MLDA			
Fatal injury crashes	3[53,54,55]	8% increase	2%–38% increase
Fatal and nonfatal injury crashes	4[60]	5% increase	2% decrease to 22% increase
Other crashes	2[56,58]	NA	22% and 186% increase
Estimated effect of raising the MLDA by 3 years (from 18 to 21) from regression-based studies[29,64–80]			
Fatalities and fatal crashes	9[30,61,65–68,73–75]	12% decrease	17%–8% decrease

[a]When 7 or more studies were available, an interquartile range is presented.
[b]A study evaluating fatal crashes among 16- and 17-year-olds[47] was not included in the summary effect measures.
MLDA, minimum legal drinking age; NA, not applicable.

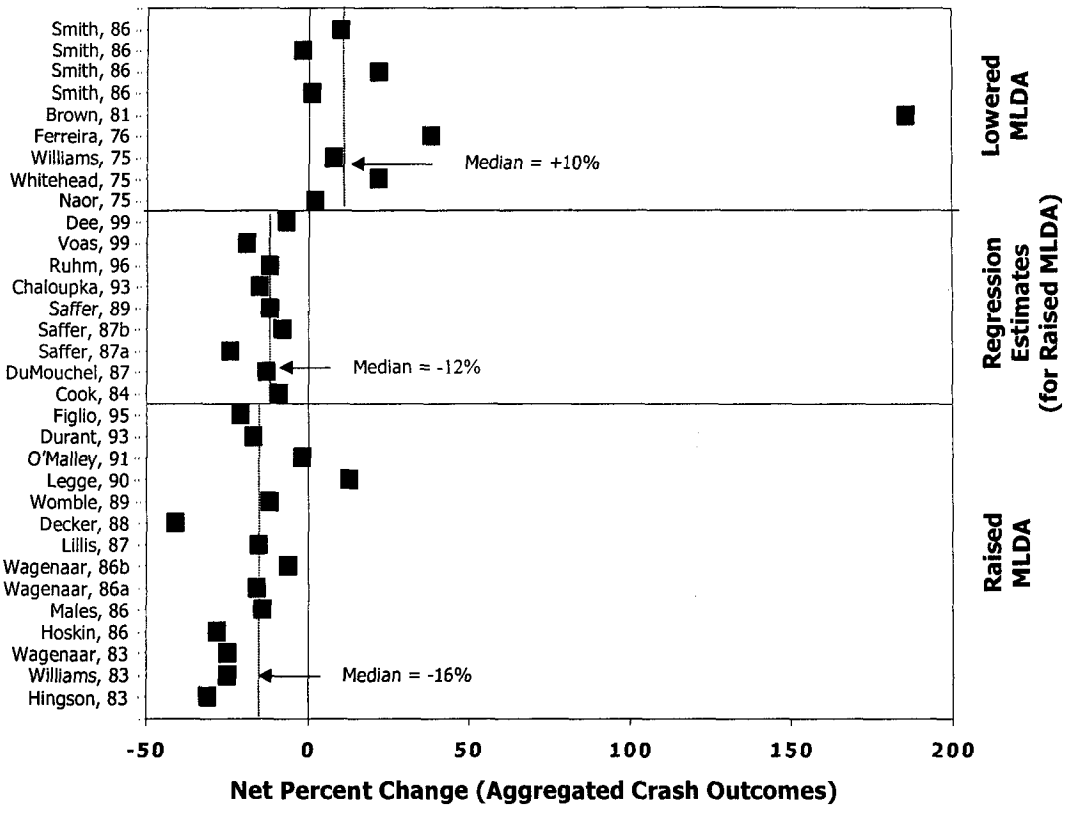


Figure 3. Percent change in aggregated crash outcomes after changes in the MLDA. The "a" and "b" in study names refer to the first or second study by the same author in that year, included in this review. Listed studies for which the author name and year are identical come from a single paper.[60]

Applicability. All of the changes in MLDA assessed in this review affected drivers aged 18 to 20 years. All studies assessed changes in state or provincial laws. Of the 33 studies included in the review, 27 were conducted in the United States,[30,36,37,39–48,50–52,54–56,61,65–68,73–75] one was conducted in the United States and Canada,[53] and the remaining studies were conducted in Australia (4 studies in one report)[60] or Canada.[58] The generalizability of these findings to other countries may be limited by differences in patterns of alcohol consumption and driving among 18- to 20-year-olds.

Other positive or negative effects. Several studies reported that raising the MLDA was associated with decreased alcohol consumption.[36,45,47,51] We did not review this literature systematically but present relevant findings in the evidence tables (available at the website www.thecommunityguide.org). Nine studies also investigated the effect of raising the MLDA on crashes involving adolescent drivers who were younger than the MLDA both before and after it was raised.[37,42,44,46,47,51,66,68,74] Although these studies indicated that raising the MLDA was associated with a median decline in crashes of 6% (interquartile range, −18% to 5%), the size of this effect was inconsistent across studies, with several showing no effect.

Some investigators have postulated that when drivers who have not been legally allowed to drink reach the MLDA, their risk of alcohol-related crash involvement will dramatically increase because of their inexperience in drinking, thus partly or completely offsetting the benefits of MLDA laws.[44,72] Studies that attempt to directly estimate the "drinking experience" effect have produced inconsistent results because of problems in statistically disentangling it from the effect of the MLDA itself.[44,67,72,81] In one study of a cohort that would be affected by both the MLDA and drinking experience effects, raising the MLDA from 18 to 21 years was estimated to decrease nighttime fatal crashes by 15% (95% CI, 3% to 27%).[67] This result is similar to the median effect estimate for MLDA alone, suggesting that if the putative drinking experience effect exists, it does not substantially diminish the benefits of raising the MLDA.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[7]

Barriers to intervention implementation. Currently, the MLDA is 21 years throughout the United States and 18 years in many other countries (e.g., Australia). The belief among some opponents of MLDA laws that

Table 7. Selective breath testing sobriety checkpoints: descriptive information about included studies

	Number of studies
Papers meeting inclusion criteria	17[85–101]
Papers excluded, limited execution quality	4[88,89,91,96]
Qualifying papers	13[85–87,90,92–95,97–101]
Papers reporting additional information on already-included studies	2[100,101]
Actual number of qualifying studies	11[85–87,90,92–95,97–99]
Study designs	
Time series with concurrent comparison group	6[85,87,90,94,97,99]
Time series, no concurrent comparison group	4[86,92,93,98]
Nonrandomized group trial	1[95]
Outcomes reported	
Fatal injury crashes	2[85,90]
Fatal and nonfatal injury crashes	6[86,90,93–95,98]
Other crash types	6[86,87,92,97–99]

prohibition of drinking among young adults unjustly punishes them for the irresponsible behavior of the subgroup that drives after drinking poses a potential barrier to the strengthening or maintenance of MLDA laws.[82]

Conclusion. According to the *Community Guide*'s rules of evidence, there is strong evidence that MLDA laws, particularly those that set the MLDA at age 21, are effective in preventing alcohol-related crashes and associated injuries.

Sobriety Checkpoints

At sobriety checkpoints, law enforcement officers systematically stop drivers to assess their degree of alcohol impairment. There are two types of sobriety checkpoints. At random breath testing (RBT) checkpoints, all drivers stopped are given breath tests for BACs. RBT checkpoints are used in Australia and several European countries. Issues about the violation of constitutional protections against unreasonable search and seizure[83] have prevented the use of RBT checkpoints in the United States. At selective breath testing (SBT) checkpoints, used in many U.S. states, police must have reason to suspect the driver stopped at a checkpoint has been drinking before a breath test can be demanded. Both types of sobriety checkpoint programs generally include media efforts to publicize the enforcement activity and the consequences of driving with a BAC above the legal limit.

The rationale for the use of checkpoints is based on deterrence theory. Although checkpoints may remove some drinking drivers from the road, their primary goal is to reduce driving after drinking by increasing the perceived risk of arrest. This perceived risk may be influenced by the level of publicity accompanying the enforcement effort, visibility of the checkpoint operations themselves, the likelihood of detection, and drivers' beliefs about their ability to avoid detection.[84]

Reviews of evidence

Effectiveness. The evidence base for this intervention included published journal articles, technical reports,

Table 8. Random breath testing sobriety checkpoints: descriptive information about included studies

	Number of studies
Papers meeting inclusion criteria	16[84,102–116]
Papers excluded, limited execution quality[a]	3[103,110,113]
Papers excluded, least suitable design quality	2[107,109]
Qualifying papers	12[84,102,104–106,108,110–112,114–116]
Papers reporting additional information on already-included studies	2[115,116]
Actual number of qualifying studies[b]	12[84,102,104–106,108,110–112,114]
Study designs	
Time series with concurrent comparison group	2[105,106]
Time series, no concurrent comparison group[b]	7[84,108,110,111,114]
Before–after with concurrent comparison group	3[102,104,112]
Outcomes reported	
Fatal injury crashes	6[84,104,110,114]
Fatal and nonfatal injury crashes (or injuries)	10[84,102,105,106,108,110,112,114]
Other crash types	1[110]
Drivers with BAC >.08	1[111]

[a]One of four studies in one paper[110] did not meet quality criteria.
[b]Three studies from one paper[110] qualified for review.
BAC, blood alcohol concentration.

Table 9. Effects of selective breath testing checkpoints on crash outcomes likely to involve alcohol: summary effects from the body of evidence

Outcome	Number of studies	Median change	Range[a]
Fatal injury crashes	2[85,90]	NA	26% and 20% decrease
Fatal and nonfatal injury crashes	6[86,90,93–95,98]	20% decrease	23%–5% decrease
Other crashes	6[86,87,92,97–99]	24% decrease	35%–13% decrease[b]
Aggregated crashes	11[85–87,90,92–95,97–99]	20% decrease	27%–13% decrease[b]

[a]When 7 or more studies were available, an interquartile range is presented.
[b]One study[99] reported data in a form that could not be converted to our summary effect measures.
NA, not applicable.

and Association for the Advancement of Automotive Medicine proceedings. We found 15 studies of the effectiveness of SBT checkpoints.[85–99] Two additional papers provided more information about an already-included study,[100,101] and one presented data in a form that could not be converted to our summary effect measure.[99] Descriptive information about the quality, study design, and outcome measures from these studies is presented in Table 7. Our search identified 17 studies of the effectiveness of RBT checkpoints (four of these studies were reported in one paper).[84,102–114] Two additional papers provided information about an already-included study.[115,116] Descriptive information about the quality, study design, and outcome measures from these studies is presented in Table 8.

Details of the 23 qualifying studies are provided at the website (www.thecommunityguide.org). Summaries of study outcomes are reported in Tables 9 (SBT) and 10 (RBT). Outcomes from studies reporting crash-related outcomes are also provided in Figures 4 (SBT) and 5 (RBT). Both SBT and RBT checkpoints consistently resulted in decreased crashes. Length of follow-up time ranged from 1 to 120 months (median, 14) and did not appear to influence the size of the declines.

One study assessed the effect of RBT checkpoints on the observed incidence of drinking and driving. This study found that during an RBT checkpoint program, the proportion of drivers with any detectable BAC level declined 13% and the proportion of drivers with BACs above 0.08 g/dL declined 24% from prior levels.[111]

Although RBT checkpoints have greater sensitivity in detecting drinking drivers than SBT checkpoints, this review found no evidence that their effectiveness for reducing alcohol-related crashes differed. None of the studies reviewed was designed to directly compare the effectiveness of RBT and SBT checkpoints, however, so these results should be interpreted with caution. Sensors that allow police to passively sample air in the car for alcohol vapors (passive alcohol sensors) can improve the detection rate at SBT checkpoints by approximately 50%.[99] If such technology becomes more widely used, the sensitivity in detecting drinking drivers at SBT checkpoints may approach that of RBT checkpoints.

Applicability. The same body of evidence used to assess effectiveness was used to assess the applicability of these interventions. Studies that met our quality criteria involved a somewhat larger scale of enforcement and publicity activity than studies that were excluded because of quality limitations. Thus, the reported results may be most generalizable to these larger-scale interventions. The studies were conducted on interventions implemented at the city,[86,87,95,97,98,102,111] county,[91] state,[84,85,90,93,94,104,105,108,110,112] and national level[114] and were evaluated in rural areas,[106,112] in urban areas,[86,87,95,97,98,102,111,112] and in mixed rural and urban areas.[84,85,90,93,94,104,105,108,110]

Other positive or negative effects. Several studies report the arrest of drivers stopped at sobriety checkpoints for other offenses, such as driving with a suspended license or carrying weapons, as an added benefit.[90,94,95,97]

One negative effect of stopping drivers at checkpoints is the resulting inconvenience and intrusion on driver privacy. According to the U.S. Supreme Court, the brief intrusion of a properly conducted sobriety checkpoint is justified in the interest of reducing alcohol-impaired driving.[117] Some civil libertarian groups have also endorsed this position.[84]

In the United States, checkpoints use established protocols to ensure that they are conducted properly.[83]

Table 10. Effects of random breath testing checkpoints on various outcomes: summary effects from the body of evidence

Outcome	Number of studies	Median change	Range[a]
Fatal injury crashes	6[84,104,110,114]	22% decrease	36%–13% decrease
Fatal and nonfatal injury crashes	10[84,102,106,107,108,110,112,114]	16% decrease	20%–11% decrease
Other crashes	2[110]	NA	26% and 15% decrease
Aggregated crashes	11[84,102,104–106,108,110,112,114]	18% decrease	22%–13% decrease
Drivers with BAC >.08%	1[111]	NA	24% decrease

[a]When 7 or more studies were available, an interquartile range is presented.
NA, not applicable; BAC, blood alcohol concentration.

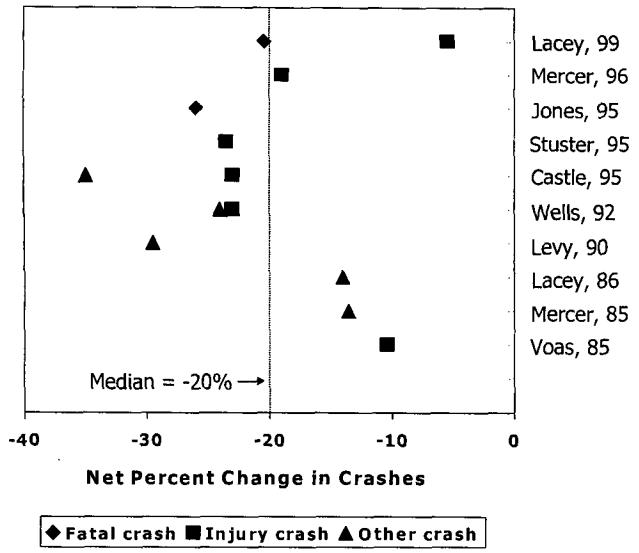


Figure 4. Percent change in crashes likely to involve alcohol after implementing selective breath testing checkpoint programs.

Common components of the protocols include selecting checkpoint locations on the basis of objective criteria (e.g., the incidence of alcohol-related crashes in the area) and stopping cars according to a predetermined system (e.g., every third car that approaches the checkpoint).[90,94,97]

Economic. Four studies[95,104,118,119] were included in the review of sobriety checkpoints. Two studies[95,118] evaluated SBT checkpoints and two studies[104,119] evaluated RBT checkpoints. All studies conducted cost–benefit analyses. Three studies[104,118,119] reported annual net benefits (the stream of benefits minus the stream of costs incurred in 1 year), and the fourth study[95] reported net benefits for the length of the intervention (9 months). Study details, adjusted results, and quality scoring for all four studies are provided in the economic evaluation summary tables at the website (www.thecommunityguide.org).

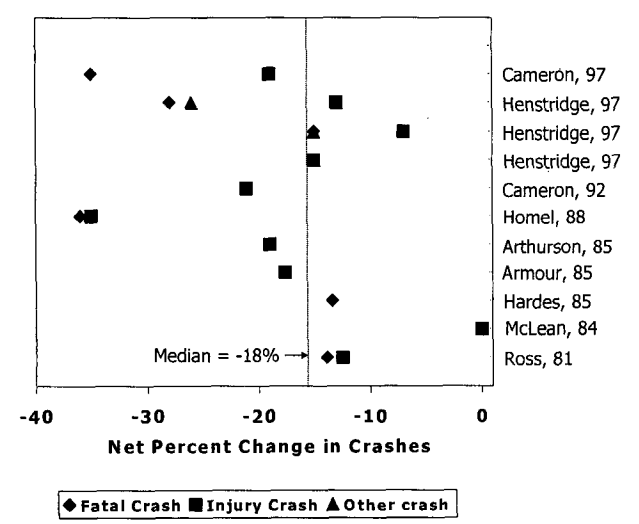


Figure 5. Percent change in crashes likely to involve alcohol after implementing random breath testing checkpoint programs. Listed studies for which the author name and year are identical come from a single paper.[110]

Selective breath testing checkpoints. The first study[118] modeled a 1-year campaign conducted in a hypothetical community of 100,000 licensed drivers in the United States. The modeled campaign consisted of 156 checkpoints (4 hours each) per year. The effect size assumed in the analysis was a 15% reduction in alcohol-related crashes. Program costs included in the analysis were personnel, equipment, travel delay, trial, punishment, and mobility loss associated with sanctioning (e.g., loss of driver's license). The estimated annual total benefit from alcohol-related crashes averted was $9.2 million (in 1997 U.S. dollars). Benefits were estimated by accounting for medical care, property damage, and public costs averted plus future earnings and quality of life gained. Estimated annual total costs of the intervention were $1.6 million. The estimated annual net benefit was $7.6 million (in 1997 U.S. dollars), resulting in a benefit-to-cost ratio[b] of $6 per dollar invested. This study was classified as very good, based on the quality assessment criteria used in the *Community Guide.*

The second study[95] evaluated a 9-month campaign conducted in four communities in California with checkpoint sites (a fifth community was a comparison group and a sixth implemented roving DWI patrols). The program consisted of 18 checkpoints per community plus publicity campaigns and education programs. Net reductions in alcohol-related crash injuries and deaths ranged from 17.5% to 31.6%. Total aggregated benefits of $3.86 million (in 1997 U.S. dollars) came from societal savings realized through injuries and fatalities avoided. Costs included personnel and equipment. Cost of the publicity campaigns and education programs were not included in the analysis. Total costs of the intervention (aggregated for four communities) were $164,552. The aggregated net benefit was $3.7 million, resulting in a benefit-to-cost ratio of $23 per dollar invested. This study was classified as satisfactory, based on the quality assessment criteria used in the *Community Guide.*

In summary, both studies show positive net benefits and, therefore, from a societal viewpoint, economic benefits of these interventions exceed costs. The hypothetical study reported net benefits almost double those reported by the California study although greater disparity was observed in the benefit-to-cost ratio ($6 in the hypothetical study vs $23 in the California study). The high benefit-to-cost ratio reported by the California study is due, in part, to the underestimation of total

costs because the analysis did not include the cost of publicity and education.

Random breath testing checkpoints. The first study[104] was conducted 3 years after statewide RBT checkpoints were introduced in New South Wales, Australia. The program included police operations, media publicity, and revised drunk-driving penalties. Annual total benefits were $228 million (in 1997 U.S. dollars) and were calculated on the basis of the assumption that 75% of the reduction in fatal crashes, serious injuries, minor injuries, and tow-away crashes was attributable to the checkpoints. Annual total program costs were $4 million (in 1997 U.S. dollars) and included personnel, equipment, publicity, and transportation. The net annual benefit reported in the study was $224 million. This study was classified as satisfactory, based on the quality assessment criteria used in the *Community Guide.*

The second study[119] evaluated a proposed nationwide RBT checkpoint intervention in The Netherlands. The proposed intervention included a publicity component and incorporated a more efficient method of transporting offenders to police stations. The checkpoint program was assumed to result in a 25% reduction in alcohol-related injury or property damage on weekend nights. Annual total benefits from cost-savings in the reduction in alcohol-related injury and property damage were estimated at $31.4 million (in 1997 U.S. dollars). The investigators did not specify the value of statistical life used to calculate the cost-savings from averted death or the procedure and assumptions to calculate cost-savings from averted injury. Annual total costs, including materials and publicity, were estimated at $15.6 million. The annual net benefit of the intervention was estimated to be $15.8 million, resulting in a benefit-to-cost ratio of $2 per dollar invested. This study was classified as good, based on the quality assessment criteria used in the *Community Guide.*

In summary, both studies showed positive net benefits (i.e., the economic benefits of the interventions are greater than the economic costs). The Australian intervention, which was more intensive and reached one in three drivers, showed larger net benefits than the modeled Netherlands intervention, which was designed to reach one in nine drivers.

Barriers to intervention implementation. Although the U.S. Supreme Court has determined that SBT checkpoints are permissible,[117] some state courts prohibit them. Where checkpoints are permitted, police concern about low arrest rates can be an important barrier.[89] Informing police officers about the general deterrence benefit of their efforts and providing them with regular feedback that links these efforts to crash prevention may decrease this frustration.[85,109]

Conclusion. According to the *Community Guide*'s rules of evidence, available studies provide strong evidence that both SBT and RBT sobriety checkpoints are effective in preventing alcohol-impaired driving, alcohol-related crashes, and associated fatal and nonfatal injuries.

Intervention Training Programs for Servers of Alcoholic Beverages

Server intervention training programs provide education and training to servers of alcoholic beverages with the goal of altering their serving practices to prevent patron intoxication and alcohol-impaired driving. These practices may include offering patrons food with drinks, delaying service to rapid drinkers, refusing service to intoxicated or underage patrons, and discouraging intoxicated patrons from driving.

People often drive after consuming alcohol in bars, clubs, and restaurants. Two analyses found that about 40% to 60% of intoxicated drivers had recently departed from a licensed drinking establishment.[120,121] Thus, altering server practices to prevent intoxication at drinking establishments may be an effective means of reducing alcohol-impaired driving. As of January 1, 2000, 11 states had established mandatory server training programs for all licensed establishments, and 10 states provided liability protection to establishments that voluntarily implemented server training.[122] Local governments can also mandate server training.

There are currently no standards for server training programs, and their implementation varies widely in terms of the content covered, instructional time, and mode of delivery (e.g., face-to-face vs videotaped). Some programs are offered in classroom settings by professional trainers, and others consist only of a video or written material that employees are encouraged to look at on their own.[123] Generally, the programs involve education about alcohol beverage control (ABC) laws and training in identifying signs of intoxication. They frequently include training in specific intervention techniques such as offering food, delaying service, or refusing service. This training may be supplemented by role-playing of intervention scenarios. Some programs also evaluate the alcohol serving policies of a drinking establishment and recommend changes to reduce intoxication such as eliminating drink promotions, serving a variety of nonalcoholic beverages, or increasing the availability of food.[124]

Factors other than server training influence serving practices in licensed establishments. These factors include enforcement of existing ABC laws,[125] server liability (or dram shop) laws and high-profile server liability cases,[126] and community coalitions to encourage responsible serving practices.[127] These factors may also influence the degree of management support that servers receive for participating in server training and for improving serving practices. Such management

support is thought to be an essential prerequisite for changes in server behavior.[123,128–130]

Reviews of evidence

Effectiveness. The evidence base for this intervention included published journal articles and technical reports. Our search identified eight studies of the effectiveness of server training.[129,131–137] Four reports provided additional information about already-included studies.[138–141] Three studies had limited execution quality and were not included in the review.[133,134,136] Details of the five included studies are provided at the website (www.thecommunityguide.org).

Two studies assessed observed server behaviors, and both studies found significant improvements after relatively intensive (4.5- to 6-hour) training programs.[132,135] One study[132] found that servers in four bars at which training was provided showed improved scores on a rating scale, reflecting both appropriate and inappropriate server behaviors relative to those in comparable bars. Another study,[135] in which interested servers in two bars received training, found an increase in appropriate interventions by trained servers in response to rapid drinking by "pseudopatrons," research assistants pretending to be patrons.

Three studies evaluating drinkers' BACs found that server training was associated with a decrease in patron intoxication.[129,135,137] One study discussed above[135] found that none of the pseudopatrons served by trained servers reached BAC levels of 0.10 g/dL, whereas 45% of those served by untrained servers did. A second study[137] that involved less-intensive server training (1 to 2 hours) at 14 drinking establishments assessed the proportion of patrons leaving the premises with BACs above 0.08 g/dL. This study found that the rate of intoxication in participating premises relative to matched comparisons decreased by 17% at a 2-week follow-up and by 28% after 3 months. The investigators noted that much of this success was attributed to a single establishment with an unusually supportive manager. In the third study,[129] conducted at a Navy enlisted club, an intensive 18-hour training course was supplemented by other policy changes such as eliminating the sale of pitchers of drinks. These changes were associated with a 33% net decrease in the percentage of patrons with estimated BACs of 0.10 g/dL or greater relative to a comparable club. Although overall alcohol consumption did not substantially decrease (−0.1 drinks, $p>.05$), there was a nonsignificant decrease in the rate of consumption (−0.8 drinks/hour, $p>.05$), suggesting that patrons drank more slowly but stayed in the establishment longer.

Finally, one study[131] evaluated the effect of a statewide 1-day mandatory server training program. On the basis of a time series analysis that included single-vehicle nighttime *fatal* crashes in other states as a covariate, server training resulted in an estimated net decrease of 23% in single-vehicle nighttime *injury* crashes.

Applicability. Of the five studies evaluated in this review, three[129,131,135] were conducted in the United States, one in Canada,[132] and one in Australia.[137] With the exception of one study,[131] all of the participating drinking establishments volunteered to have their servers attend the training. Thus, managers who chose to participate in the evaluated server training programs may have been unusually supportive of the goals of the programs. Three of the five programs evaluated[129,132,135] were also implemented on a very limited scale, in a small number of drinking establishments. These training programs were relatively time intensive (longer than 4 hours), involved face-to-face training, and covered a broad curriculum, including specific intervention practices in contrast with training programs generally in use, which vary widely in intensity, mode of delivery, and content.[123] Thus, the studies we reviewed may reflect the efficacy of server training under near-optimal conditions. It is not clear to what extent these findings might generalize to larger-scale community-wide programs, to programs with substantially different training methods or content, or to programs that do not recruit well-motivated managers. Finally, only one study[131] evaluated outcomes beyond a 3-month follow-up period, leaving the long-term effect of this intervention open to question.

Other positive and negative effects. None of the studies reviewed examined consequences of intoxication other than those associated with drinking and driving. It is plausible, however, that the benefits of decreased levels of intoxication resulting from improved server practices would extend to other forms of alcohol-related injury, violence, and crime. In one study, there was also a trend toward servers receiving increased gratuities after training.[135] No negative effects of server training programs were noted.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[7]

Barriers to intervention implementation. Resistance to server training by managers of drinking establishments is a potential barrier to effective implementation of this intervention. Although many managers of drinking establishments are supportive of the concept of server training,[136] concerns about the effect on profits can seriously erode their support for improved server practices.[141] One study that addressed this issue by examining gross receipts found no noticeable reduction after server training.[129] That study was conducted at a Navy base enlisted club, however, and the finding may not generalize to other types of drinking establishments. In addition to profitability concerns, some managers also react negatively to the concept of "policing" their customers.[141] Management support for server training

programs could be increased by offering positive incentives (e.g., insurance discounts) to establishments that improve serving practices,[142] by strengthening or highlighting disincentives for irresponsible practices (e.g., stronger enforcement of ABC laws),[125] and by building broad community support for such programs.[136]

Maintaining the consistency of server training programs is essential for effective implementation. Given the high employee turnover rate for servers, going beyond a "demonstration" training program requires that training sessions be offered on a continuing basis and that their quality be consistent across time and locations. Problems in staffing and in scheduling training sessions can result in decreased quality of implementation.[137] Although less-intensive server training programs (e.g., video-based) are easier and less expensive to implement, their effectiveness is not known.

Conclusion. According to the *Community Guide*'s rules of evidence, there is sufficient evidence that intensive, high-quality, face-to-face server training, when accompanied by strong and active management support, is effective in reducing the level of intoxication in patrons. This type of training is likely to have a desirable effect on alcohol-impaired driving if the affected patrons cease drinking or continue drinking in relatively safe environments after leaving the drinking establishment.[128] The optimal conditions for this situation would exist if server training were established at all drinking establishments within a community. In this review, only two studies that met the quality criteria evaluated community-wide server training programs. Thus, further research is needed about the fundamental question of whether server intervention training programs delivered community-wide are effective at decreasing intoxication and, ultimately, alcohol-impaired driving.

Research Issues

Effectiveness

Sufficient or strong evidence exists that the effectiveness of the five interventions reviewed reduces alcohol-impaired driving. However, important issues related to the effectiveness of these interventions require further research.

General questions

- How do interventions to reduce alcohol-impaired driving interact with each other (e.g., .08 BAC laws and administrative license revocation)?
- What effects do these interventions have on long-term changes in social norms about drinking and driving?

Laws

- How do variations in enforcement levels influence the effectiveness of laws to reduce alcohol-impaired driving?
- What are the independent effects of publicity on the effectiveness of laws to reduce alcohol-impaired driving?
- Does public compliance with new laws change in a predictable manner over time?

Sobriety checkpoints

- Does the use of passive alcohol sensors at sobriety checkpoints improve their deterrent effects?
- Are the deterrent effects of sobriety checkpoints diminished if warning signs are posted that allow drivers to avoid the checkpoints?
- How do various configurations of sobriety checkpoints (e.g., intermittent blitzes vs continuous, weekend nights vs random time periods, number of officers per checkpoint) affect deterrence?
- What level of enforcement and publicity about sobriety checkpoints is necessary to maintain effectiveness over time?

Server intervention training

- Are server intervention training programs delivered community-wide effective at decreasing alcohol-impaired driving and alcohol-related crashes?
- What essential content areas should be included in all server intervention training programs?
- What effect does the method by which training is delivered (e.g., videotapes, lectures, role-playing) have on the effectiveness of server training programs?
- How do mandatory versus voluntary server training programs differ with respect to:
  —management support for program goals?
  —level of participation in training programs?
  —overall effectiveness for decreasing patron BACs and drinking and driving?
- What specific management policies and practices are necessary to get the maximum benefits from server intervention training?
- What is the long-term effect of server intervention training programs? Are "booster sessions" required to maintain effectiveness?
- What effect does server intervention training have on alcohol sales, overall revenues, and tips?

Applicability

These five interventions should be applicable in most target populations and settings. However, questions remain about possible differences in the effectiveness of each intervention for specific settings and subgroups. For example:

- Are these interventions equally effective in rural and urban settings?
- Are these interventions equally effective when applied to populations with different baseline levels of alcohol-impaired driving?

- Does targeting publicity efforts to specific subpopulations (e.g., young drivers, ethnic minorities, men) improve the effectiveness of interventions to reduce alcohol-impaired driving?

Other Positive or Negative Effects

Few other positive and negative effects were reported in this body of literature. Further research about the following questions would be useful:

- What proportion of youths charged with violating zero tolerance laws had BAC levels elevated enough to warrant a more serious drinking-driving offense?
- Do interventions to reduce alcohol-impaired driving reduce other forms of alcohol-related injury?

Economic Evaluations

Little economic evaluation information was available. Research is warranted to answer the basic economic questions: What are the cost-benefit, cost utility, and cost-effectiveness of interventions to reduce alcohol-impaired driving?

Barriers to Implementation

Several of the interventions reviewed face barriers to effective implementation. Research into the following areas may help to overcome these barriers:

- What role can community coalitions play in removing barriers to implementing interventions designed to prevent alcohol-impaired driving?
- What are the most effective means of disseminating research findings about effectiveness to groups that want to implement interventions?
- What forms of incentives (e.g., insurance discounts) are most helpful for increasing management and owner support for server intervention training?
- How can the costs of interventions to prevent alcohol-impaired driving be shared or subsidized?
- What situational and environmental influences help or hinder the implementation of server intervention training?

Discussion

Interventions to prevent alcohol-impaired driving are implemented within the social and legal context of a community. Although these reviews evaluate each intervention as an independent activity, effective prevention of impaired driving requires a comprehensive and systematic approach that addresses various individual and ecologic influences on drinking and driving behavior.[143–145] These reviews can help decision makers identify and implement effective interventions that fit within an overall prevention strategy.

We thank the following individuals for their contributions to this review: Erin Finley, Krista Hopkins, and Patryce Young-Curtis, *Research Assistants*; Sandra Bonzo and Joanna Taliano, *Research Librarians*; Kate W. Harris, *Editor*; our **Consultation Team**—J. C. Bolen, PhD, MPH, National Center for Chronic Disease Prevention and Health Promotion, CDC, Atlanta, GA; R. D. Brewer, MD, MSPH, Nebraska Department of Health, Lincoln; S. D. Bryn, MPH, Health Resources Services Administration, Rockville, MD; F. M. Council, PhD, University of North Carolina, Chapel Hill; R. W. Denniston, MA, Substance Abuse and Mental Health Services Administration, Rockville, MD; A. C. Gielen, ScD, ScM, Johns Hopkins University, Baltimore, MD; S. Gorcowski, MA, National Highway Traffic Safety Administration, Washington, DC; C. A. Hurley, BA, National Safety Council, Washington, DC; B. H. Jones, MD, MPH, National Center for Injury Prevention and Control, CDC, Atlanta, GA; T. A. Karlson, PhD, University of Wisconsin, Madison; M. R. Kinde, MPH, Minnesota Department of Health, Minneapolis; D. W. Lawrence, MPH, RN, San Diego State University, CA; S. E. Martin, PhD, National Institute for Alcohol Abuse and Alcoholism, Rockville, MD; J. A. McKnight, PhD, National Public Service Research Institute, Landover, MD; A. D. Mickalide, PhD, CHES, National SAFE KIDS Campaign, Washington, DC; L. F. Novick, MD, MPH, Onandaga County Department of Health, Syracuse, NY; F. P. Rivara, MD, MPH, University of Washington, Seattle; C. W. Runyan, PhD, MPH, University of North Carolina, Chapel Hill; R. J. Smith, MS, Health Resources and Services Administration, Rockville, MD; P. F. Waller, PhD, University of Michigan, Ann Arbor; A. F. Williams, PhD, Insurance Institute for Highway Safety, Arlington, VA; and our **Abstraction Team**—J. L. Alongi, MPH, Los Angeles County Department of Health Services, Los Angeles, CA; P. Bellas, MD, MPH, South Bay Family Healthcare Center, Redondo Beach, CA; S. Corbett-Perez, MHSE, University of Florida, Gainesville; R. A. Eidman, MPH, Triple Hayz Corporation, Los Angeles, CA; J. Kattapong, MA, MD, MPH, Social Security Administration, Tucson, AZ; S. Levesque, MD, MPH, Inscription House Health Center, Navajo/Indian Health Service, Shoto, AZ; D. Pallin, MD, MPH, Mt. Sinai School of Medicine, New York, NY; M. Patterson, MS, PhD, University of Washington and Harborview Injury Prevention Research Center, Seattle; S. L. Usdan, PhD, Mississippi State University, Mississippi State; C. Ward, Johns Hopkins School of Public Health, Dr. PH candidate, Baltimore, MD.

References

1. National Highway Traffic Safety Administration. Traffic safety facts, 1999: a compilation of motor vehicle crash data from the Fatality Analysis Reporting System and the General Estimates System. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 100.
2. National Center for Health Statistics. Healthy People 2000 Review, 1998–99. Hyattsville, MD: Public Health Service, 1999. DHHS Pub No (PHS) 99-1256.
3. Bureau of the Census, Economics and Statistics Administration, U.S. Department of Commerce. Census data to calculate the rate of alcohol-related motor vehicle crash fatalities. 2000. Available at: www.census.gov/population/www/estimates/popest.html. Accessed November 1, 2000.
4. U.S. Department of Health and Human Services. Healthy People 2010, 2nd ed. With understanding and improving health and objectives for improving health, 2 vols. Washington, DC: U.S. Government Printing Office, 2000.
5. Task Force on Community Preventive Services. Recommendations to

reduce injuries to motor vehicle occupants: increasing child safety seat use, increasing safety belt use, and reducing alcohol-impaired driving. Am J Prev Med 2001;21(suppl 4):16–22.
6. Briss PA, Zaza S, Pappaioanou M, et al., Task Force on Community Preventive Services. Developing an evidence-based Guide to Community Preventive Services—methods. Am J Prev Med 2000;18(suppl 1):35–43.
7. Zaza S, Carande-Kulis VG, Sleet DA, et al., and the Task Force on Community Preventive Services. Methods for conducting systematic reviews of the evidence of effectiveness and economic efficiency of interventions to reduce injuries to motor vehicle occupants. Am J Prev Med 2001;21(suppl 4):23–30.
8. National Highway Traffic Safety Administration, National Center for Statistics and Analysis. Fatality Analysis Reporting System (FARS). 2001. Available at: www.nhtsa.dot.gov/people/ncsa/fars.html. Accessed February 21, 2001.
9. Klein T. A method for estimating posterior BAC distributions for persons involved in fatal traffic accidents: final report. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1986. DOT HS 807 094.
10. Hingson R, Heeren T, Winter M. Lowering state legal blood alcohol limits to 0.08%: the effect on fatal motor vehicle crashes. Am J Public Health 1996;86:1297–9.
11. Apsler R, Char AR, Harding WM, Klein TM. The effects of .08 BAC laws. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, 1999. DOT HS 808 892.
12. Foss RD, Stewart JR, Reinfurt DW. Evaluation of the effects of North Carolina's 0.08% BAC law. Chapel Hill, NC: University of North Carolina Highway Safety Research Center, 1998. DOT HS 808 893. Available at: www.nhtsa.dot.gov/people/ncsa/nc08.html. Accessed September 6, 2001.
13. Hingson R, Heeren T, Winter M. Effects of recent 0.08% legal blood alcohol limits on fatal crash involvement. Inj Prev 2000;6:109–14.
14. Johnson D, Fell J. The impact of lowering the illegal BAC limit to .08 in five states. 39th Annual Proceedings, Association for the Advancement of Automotive Medicine, October 16–18, 1995, Chicago, Illinois.
15. Research and Evaluation Associates. The effects following the implementation of an 0.08 BAC limit and administrative per se law in California. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, 1991. DOT HS 807 777.
16. Rogers PN. The general deterrent impact of California's 0.08% blood alcohol concentration limit and administrative per se license suspension laws, Volume 1. Sacramento, CA: California Department of Motor Vehicles, Research and Development Section, 1995. No. CAL-DMV-RSS-95-158.
17. Scopatz RA. Methodological study of between-states comparisons, with particular application to .08% BAC law evaluation. Paper presented at the Transportation Research Board 77th annual meeting, January 11–15, 1998, Washington, DC.
18. Voas RB, Tippets AS, Fell J. The relationship of alcohol safety laws to drinking drivers in fatal crashes. Accid Anal Prev 2000;32:483–92.
19. Department of Transportation and Related Agencies Appropriations Act, 2001. Public law no. 106-346. 2000.
20. Zador PL, Krawchuk SA, Voas RB. 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 Stud Alcohol 2000;61:387–95.
21. National Highway Traffic Safety Administration. On DWI laws in other countries. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 037.
22. Hingson R, Heeren T, Winter M. Lower legal blood alcohol limits for young drivers. Public Health Rep 1994;109:738–44.
23. Blomberg RD. Lower BAC limits for youth: evaluation of the Maryland .02 law. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1992. DOT HS 807 860.
24. Haque MO, Cameron M. Effect of the Victorian Zero BAC legislation on serious casualty accidents: July 1984–December 1985. J Safety Res 1989;20: 129–37.
25. Lacey JH, Jones RK, Wiliszowski CH. Zero tolerance laws for youth: four states' experience. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000. DOT HS 809 053.
26. Maisey GE. The effect of lowering the statutory alcohol limit for first year drivers from 0.08 to 0.02 gm/100ml (monograph). Perth, Western Australia: Western Australia Police Department, Research and Statistics Section, 1984. Research Report 84/2.
27. Smith DI. Effect of low proscribed blood alcohol levels (BALs) on traffic accidents among newly-licensed drivers. Med Sci Law 1986;26:144–8.
28. Streff FM, Hopp ML. Evaluation of Michigan's under age 21 zero-tolerance alcohol-impaired driving law. Ann Arbor, MI: University of Michigan Transportation Research Institute, 1997. UMTRI 97-50.
29. Voas RB, Lange JE, Tippetts AS. Enforcement of the zero tolerance law in California: a missed opportunity? 42nd Annual Proceedings: Association for the Advancement of Automotive Medicine, October 5–7, 1998. Charlottesville, VA. pp. 369–383.
30. Voas RB, Tippetts AS, Fell J. The United States limits drinking by youth under age 21: Does this reduce fatal crash involvements? 43rd Annual Proceedings Association for the Advancement of Automotive Medicine, September 20–21, 1999. Barcelona (Sitges), Spain. pp. 265–78.
31. Hingson R, Heeren T, Morelock S. Effects of Maine's 1982 .02 law to reduce teenage driving after drinking. Alcohol Drugs Driving 1989;5:25–36.
32. Hingson R, Heeren T, Howland J, Winter M. Reduced BAC limits for young people (impact on night fatal crashes). Alcohol Drugs Driving 1991;7:117–27.
33. Quinlan KP, Brewer RD, Sleet DA, Dellinger AM. Child passenger deaths and injuries involving drinking drivers. JAMA 2000;283:2249–52.
34. Miller TR, Lestina DC, Spicer RS. Highway crash costs in the United States by driver age, blood alcohol level, victim age, and restraint use. Accid Anal Prev 1998;30:137–50.
35. Carande-Kulis VG, Maciosek MV, Briss PA, et al. and the Task Force on Community Preventive Services. Methods for systematic reviews of economic evaluations for the Guide to Community Preventive Services. Am J Prev Med 2000;18(suppl 1):75–91.
36. O'Malley PM, Wagenaar AC. Effects of minimum drinking age laws on alcohol use, related behaviors and traffic crash involvement among American youth: 1976–1987. J Stud Alcohol 1991;52:478–91.
37. Decker MD, Graitcer PL, Schaffner W. Reduction in motor vehicle fatalities associated with an increase in the minimum drinking age. JAMA 1988;260: 3604–10.
38. MacKinnon DP, Woodward JA. The impact of raising the minimum drinking age on driver fatalities. Int J Addict 1986;21:1331–8.
39. Legge J Jr. Reforming highway safety in New York State: an evaluation of alternative policy interventions. Soc Sci Q 1990;71:373–82.
40. Figlio DN. Effect of drinking age laws and alcohol-related crashes: time-series evidence from Wisconsin. J Policy Anal Manage 1995;14:555–66.
41. Womble K. Impact of minimum drinking age laws on fatal crash involvements: an update of the NHTSA analysis. J Traffic Safety Educ 1989;37:4–5.
42. Wagenaar AC, Maybee R. Legal minimum drinking age in Texas: effects of an increase from 18 to 19. J Safety Res 1986;17:165–78.
43. Hoskin AF, Yalung Mathews D, Carraro BA. Effect of raising the legal minimum drinking age on fatal crashes in 10 states. J Safety Res 1986;17: 117–21.
44. Males M. Minimum purchase age for alcohol and young-driver fatal crashes: a long-term view. J Legal Stud 1986;15:181–211.
45. Hingson R, Scotch N, Mangione T, et al. Impact of legislation raising the legal drinking age in Massachusetts from 18 to 20. Am J Public Health 1983;73:163–9.
46. Williams AF, Zador PL, Harris SS, Karpf RS. The effect of raising the legal minimum drinking age on involvement in fatal crashes. J Legal Stud 1983;12:169–79.
47. Smith RA, Hingson RW, Morelock S, et al. Legislation raising the legal drinking age in Massachusetts from 18 to 20: effect on 16 and 17 year olds. J Stud Alcohol 1984;45:534–9.
48. Wagenaar AC. Preventing highway crashes by raising the legal minimum age for drinking: the Michigan experience 6 years later. J Safety Res 1986;17:101–9.
49. Vingilis E, Smart RG. Effects of raising the legal drinking age in Ontario. Br J Addict 1981;76:415–25.
50. Durant R, Legge JS. Policy design, social regulation and theory building: lessons from the traffic safety policy arena. Political Res Q 1993;46:641–56.
51. Lillis R, Williams T, Williford W. The impact of the 19-year-old drinking age in New York. Advances in Substance Abuse 1987;Suppl 1, Control Issues in Alcohol Abuse Prevention: Strategies for States and Communities:133–46.
52. Wagenaar AC. Raising the legal drinking age in Maine: impact on traffic accidents among young drivers. Int J Addict 1983;18:365–77.
53. Williams AF, Rich RF, Zador PL. The legal minimum drinking age and fatal motor vehicle crashes. J Legal Stud 1975;4:219–39.
54. Naor EM, Nashold RD. Teenage driver fatalities following reduction in the legal drinking age. J Safety Res 1975;7:74–9.
55. Ferreira J, Sickerman A. The impact of Massachusetts reduced drinking age on auto accidents. Accid Anal Prev 1976;8:229–39.
56. Brown DB, Maghsoodloo SA. A study of alcohol involvement in young

driver accidents with the lowering of the legal age of drinking in Alabama. Accid Anal Prev 1981;13:319–22.
57. Zylman R. Fatal crashes among Michigan youth following reduction of legal drinking age. Q J Stud Alcohol 1974;35:283–6.
58. Whitehead PC, Craig J, Langford N, MacArthur C, Stanton B, Ferrence RG. Collision behavior of young drivers: impact of the change in the age of majority. J Stud Alcohol 1975;36:1208–23.
59. Bako G, Mackenzie WC, Smith ESO. The effect of legislated lowering of the drinking age on total highway accidents among young drivers in Alberta, 1970–1972. Can J Public Health 1976;67:161–3.
60. Smith DI, Burvill PW. Effect on traffic safety of lowering the drinking age in three Australian states. J Drug Issues 1986;16:183–98.
61. Ruhm CJ. Alcohol policies and highway vehicle fatalities. J Health Econ 1996;15:435–54.
62. Asch P, Levy DT. Does the minimum drinking age affect traffic fatalities? J Policy Anal Manage 1987;6:180–92.
63. Wilkinson JT. Reducing drunken driving: Which policies are most effective? South Econ J 1987;54:322–34.
64. Legge JS Jr, Park J. Policies to reduce alcohol-impaired driving: evaluating elements of deterrence. Soc Sci Q 1994;75:594–606.
65. Saffer H, Chaloupka F. Breath testing and highway fatality rates. Appl Econ 1989;21:901–12.
66. Saffer H, Grossman M. Drinking age laws and highway mortality rates: cause and effect. Econ Inquiry 1987;25:403–17.
67. DuMouchel W, Williams AF, Zador P. Raising the alcohol purchase age: its effects on fatal motor vehicle crashes in twenty-six states. J Legal Stud 1987;16:249–66.
68. Cook PJ, Tauchen G. The effect of minimum drinking age legislation on youthful auto fatalities. J Legal Stud 1984;13:169–90.
69. Robertson LS. Blood alcohol in fatally injured drivers and the minimum legal drinking age. J Health Polit Policy Law 1989;14:817–25.
70. Colon I, Cutter HSG. The relationship of beer consumption and state alcohol and motor vehicle policies to fatal accidents. J Safety Res 1983;14: 84–9.
71. Colon I. The alcohol beverage purchase age and single-vehicle highway fatalities. J Safety Res 1984;15:159–62.
72. Asch P, Levy DT. Young driver fatalities: the roles of drinking age and drinking experience. South Econ J 1990;57:512–20.
73. Chaloupka FJ, Saffer H, Grossman M. Alcohol control policies and motor vehicle fatalities. J Legal Stud 1993;22:161–86.
74. Saffer H, Grossman M. Beer taxes, the legal drinking age, and youth motor vehicle fatalities. J Legal Stud 1987;16:351–74.
75. Dee TS. State alcohol policies, teen drinking and traffic fatalities. J Public Econ 1999;72:289–315.
76. Houston DJ, Richardson LE, Neeley GW. Legislating traffic safety: a pooled time series analysis. Soc Sci Q 1995;76:328–45.
77. Houston DJ, Richardson LE, Neeley GW. Mandatory seat belt laws in the states: a study of fatal and severe occupant injuries. Eval Rev 1996;20:146–59.
78. Arnold R. Effect of raising the legal drinking age on driver involvement in fatal crashes: the experience of thirteen states. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1985. DOT HS 806 902.
79. Wagenaar AC. Effects of an increase in the legal minimum drinking age. Public Health Policy 1981;2:206–24.
80. Wagenaar AC. Effects of the raised legal drinking age on motor vehicle accidents in Michigan. HSRI Res Rev 1981;11:1–8.
81. Skinner D, Hoxie P. Effects of minimum drinking age laws on highway fatalities. Cambridge, MA: National Highway Traffic Safety Administration, Transportation Systems Center, 1989. DOT-TSC-HS970-PM-89-1.
82. Ross H. Drunk driving: social policy for saving lives. New Haven: Yale University Press, 1992.
83. National Highway Traffic Safety Administration. The use of sobriety checkpoints for impaired driving enforcement. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1990. DOT HS 807 656.
84. Homel R, Carseldine D, Kearns I. Drink-driving countermeasures in Australia. Alcohol Drugs Driving 1988;4:113–44.
85. Castle SP, Thompson JD, Spataro JA, et al. Early evaluation of a statewide sobriety checkpoint program. 39th annual proceedings, Association for the Advancement of Automotive Medicine, October 16–18, 1995, Chicago, IL. pp. 65–78.
86. Jones R, Joksch H, Lacey J, Wiliszowski C, Marchetti L. Site report: Wichita, Kansas field test of combined speed, alcohol, and safety belt enforcement strategies. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1995. DOT HS 808 244.
87. Lacey JH, Stewart JR, Marchetti LM, Popkin CK, Murphy PV. Enforcement and public information strategies for DWI (driving-while-intoxicated) general deterrence: ARREST DRUNK DRIVING—the Clearwater and Largo, Florida experience. Chapel Hill, NC: University of North Carolina Highway Safety Research Center, 1986.
88. Lacey JH, Marchetti LM, Stewart JR, et al. Enforcement and public information strategies for DWI general deterrence: the Indianapolis, Indiana experience. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1988. DOT HS 807 434.
89. Lacey JH, Jones RK. Assessment of changes in DWI enforcement/level: final report. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1991. DOT HS 807 690.
90. Lacey JH, Jones RK, Smith RG. Evaluation of checkpoint Tennessee: Tennessee's statewide sobriety checkpoint program. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1999. DOT HS 808 841.
91. Levy D, Shea D, Asch P. Traffic safety effects of sobriety checkpoints and other local DWI programs in New Jersey. Am J Public Health 1989;79: 291–3.
92. Levy DT, Asch P, Shea D. An assessment of county programs to reduce driving while intoxicated. Health Educ Res 1990;5:247–56.
93. Mercer GW. The relationships among driving while impaired charges, police drinking-driving roadcheck activity, media coverage and alcohol-related casualty traffic accidents. Accid Anal Prev 1985;17:467–74.
94. Mercer GW, Cooper PJ, Kristiansen LA. A cost/benefit analysis of a 5-month intensive alcohol-impaired driving road check campaign. 40th annual proceedings of the Association for the Advancement of Automotive Medicine, October 7–9, 1996, Vancouver, British Columbia. pp. 283–92.
95. Stuster JW, Blowers PA. Experimental evaluation of sobriety checkpoint programs. Washington, DC: U.S. Department of Transportation, National Highway Safety Traffic Administration, 1995. DOT HS 808 287.
96. Vingilis E, Salutin L. A prevention programme for drinking and driving. Accid Anal Prev 1980;12:267–74.
97. Voas RB, Rhodenzer E, Lynn C. Evaluation of Charlottesville checkpoint operation: Final report, December 30, 1983 to December 31, 1984. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1985. US DOT Contract no. DTNH 22-83-C-05088.
98. Wells JK, Preusser DF, Williams AF. Enforcing alcohol-impaired driving and seat belt use laws, Binghamton, NY. J Safety Res 1992;23:63–71.
99. Voas RB, Holder HD, Gruenewald PJ. The effect of drinking and driving interventions on alcohol-involved traffic crashes within a comprehensive community trial. Addiction 1997;92:S221–S236.
100. Levy D. Methodologies for the evaluation of local traffic safety programs: with an application to New Jersey DWI programs. Eval Program Plann 1988;11:255–66.
101. Vingilis E, Salutin L, Chan G. R.I.D.E. (Reduce Impaired Driving in Etobicoke): a driving-while-impaired countermeasure programme, one-year evaluation. Toronto: Addiction Research Foundation, 1979.
102. Armour M, Monk K, South D, Chomiak G. Evaluation of the 1983 Melbourne random breath testing campaign: interim report, casualty accident analysis. Melbourne, Australia: Victoria Road Traffic Authority, 1985. N8-85.
103. Armstrong BK, Howell CM. Trends in injury and death in motor vehicle accidents in Australia in relation to the introduction of random breath testing. Aust Drug Alcohol Rev 1988;7:251–9.
104. Arthurson RM. Evaluation of random breath testing. Sydney: Traffic Authority of New South Wales, 1985. Research Note RN 10/85.
105. Cameron MH, Cavallo A, Sullivan G. Evaluation of the random breath testing initiative in Victoria, 1989–1991: multivariate time series approach. Melbourne, Australia: Monash University Accident Research Centre, 1992. Report 38.
106. Cameron M, Diamantopolou K, Mullan N, Dyte D, Gantzer S. Evaluation of the country random breath testing and publicity program in Victoria, 1993–1994. Melbourne: Monash University Accident Research Center, 1997. Report 126.
107. Dunbar JA, Penttila A, Pikkarainen J. Drinking and driving: success of random breath testing in Finland. Br Med J 1987;295:101–3.
108. Hardes G, Gibberd RW, Lam P, Callcott R, Dobson AJ, Leeder SR. Effects of random breath testing on hospital admissions of traffic-accident casualties in the Hunter Health Region. Med J Aust 1985;142:625–6.
109. Hendrie D, Cooper L, Ryan G, Kirov C. Review of the random breath testing program in Western Australia in 1996/1997. Nedlands, WA 6907:

Road Accident Prevention Research Unit, Department of Public Health, the University of Western Australia, 1998. Research Report RR67.
110. Henstridge J, Homel R, Mackay P. The long-term effects of random breath testing in four Australian states: a time series analysis. Canberra, Australia: Federal Office of Road Safety, 1997. No. CR 162.
111. McCaul KA, McLean AJ. Publicity, police resources and the effectiveness of random breath testing. Med J Aust 1990;152:284–6.
112. McLean AJ, Clark MS, Dorsch MM, Holubowycz OT, McCaul KA. Random breath testing in South Australia: effects on drink-driving. Adelaide, South Australia: NHMRC Road Accident Research Unit, University of Adelaide, 1984. HS 038 357.
113. Paciullo G. Random breath testing in New South Wales. Med J Aust 1983;1:620–1.
114. Ross HL, McCleary R, Epperlein T. Deterrence of drinking and driving in France: an evaluation of the law of July 12, 1978. Law Soc Rev 1981;16: 345–74.
115. Homel R. The impact of random breath testing in New South Wales, December 1982 to February 1983. Med J Aust 1983;616–9.
116. Homel R. Drink-driving law enforcement and the legal blood alcohol limit in New South Wales. Accid Anal Prev 1994;26:147–55.
117. Michigan Department of State Police v Sitz, 496 U.S. 444, 110 L. Ed. 2d 412, 1990 U.S. LEXIS 3144, 110 S. Ct. 2481, 58 U.S.L.W. 4781 (1990).
118. Miller TR, Galbraith MS, Lawrence BA. Costs and benefits of a community sobriety checkpoint program. J Stud Alcohol 1998;59:462–8.
119. Wesemann P. Costs and benefits of police enforcement in the Netherlands. In: Perrine MW, ed. Alcohol, drugs, & traffic safety: proceedings of the 11th International Conference on Alcohol, Drugs & Traffic Safety, Chicago, IL, October 24–27, 1989. Chicago, IL: National Safety Council, 1990.
120. O'Donnell MA. Research on drinking locations of alcohol-impaired drivers: implications for prevention policies. J Public Health Policy 1985;6:510–25.
121. Lang E, Stockwell TR. Drinking locations of drink-drivers: an analysis of accident and non-accident cases. Accid Anal Prev 1991;23:573–84.
122. Alcohol Epidemiology Program. Alcohol policies in the United States: highlights from the 50 states. Minneapolis: University of Minnesota, 2000.
123. Toomey TL, Kilian GR, Gehan JP, Perry CL, Jones-Webb R, Wagenaar AC. Qualitative assessment of training programs for alcohol servers and establishment managers. Public Health Rep 1998;113:162–9.
124. Geller ES, Elder JP, Hovell MF, Sleet DA. Behavior change approaches to deterring alcohol-impaired driving. In: Ward W, Lewis FM, eds. Advances in health education and promotion, Vol. 3. London, England: Jessica Kingsley, 1991.
125. McKnight AJ, Streff FM. The effect of enforcement upon service of alcohol to intoxicated patrons of bars and restaurants. Accid Anal Prev 1994;26:79–88.
126. Holder H, Wagenaar A, Saltz RF, Mosher J, Janes K. Alcoholic beverage server liability and the reduction of alcohol-related problems: evaluation of dram shop laws (final report). Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1990. DOT HS 807 628.
127. Hauritz M, Homel R, McIlwain G, Burrows T, Townsley M. Reducing violence in licensed venues through community safety action projects: the Queensland experience. Contemp Drug Problems 1998;25:511–51.
128. Single E. Server intervention: a new approach to the prevention of impaired driving. Health Educ Res 1990;5:237–45.
129. Saltz RF. The role of bars and restaurants in preventing alcohol-impaired driving: an evaluation of server intervention. Eval Health Professions 1987;10:5–27.
130. Saltz RF. Research needs and opportunities in server intervention programs. Health Educ Q 1989;16:429–38.
131. Holder HD, Wagenaar AC. Mandated server training and reduced alcohol-involved traffic crashes: a time series analysis of the Oregon experience. Accid Anal Prev 1994;26:89–97.
132. Gliksman L, McKensie D, Single E, Douglas R, Brunet S, Moffatt K. The role of alcohol providers in prevention: an evaluation of a server intervention programme. Addiction 1993;88:1195–203.
133. McKnight AJ. Factors influencing the effectiveness of server-intervention education. J Stud Alcohol 1991;52:389–97.
134. Howard-Pitney B, Johnson MD, Altman DG, Hopkins R, Hammond N. Responsible alcohol service: a study of server, manager, and environmental impact. Am J Public Health 1991;81:197–9.
135. Russ NW, Geller ES. Training bar personnel to prevent drunken driving: a field evaluation. Am J Public Health 1987;77:952–4.
136. Saltz RF, Stanghetta P. A community-wide responsible beverage service program in three communities: early findings. Addiction 1997;92(suppl 2):s237–s249.
137. Lang E, Stockwell T, Rydon P, Beel A. Can training bar staff in responsible serving practices reduce alcohol-related harm? Drug Alcohol Rev 1998; 17:39–50.
138. Geller ES, Russ NW, Delphos WA. Does server intervention training make a difference? Alcohol Health Res World 1987;11:64–9.
139. McKnight AJ. Development and field test of a responsible alcohol service program. Volume III: Final results. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1989. DOT HS 807 449.
140. Saltz RF. Server intervention: Will it work? Alcohol Health Res World 1986;10:12–9.
141. Stockwell TR, Rydon P, Lang E, Beel AC. An evaluation of the "Freo Respects You" responsible alcohol service project. Perth, Western Australia: National Centre for Research into the Prevention of Drug Abuse, Division of Health Sciences, Curtin University of Technology, 1993. NDRI Technical Report No. T40.
142. Peters J. Beyond server training: an examination of future issues. Alcohol Health Res World 1986;10:24–7.
143. DeJong W, Hingson R. Strategies to reduce driving under the influence of alcohol. Annu Rev Public Health 1998;19:359–78.
144. Holder HD, Saltz RF, Grube JW, Voas RB, Gruenewald PJ, Treno AJ. A community prevention trial to reduce alcohol-involved accidental injury and death: overview. Addiction 1997;92:S155-S171.
145. Liu S, Siegel PZ, Brewer RD, Mokdad AH, Sleet DA, Serdula M. Prevalence of alcohol-impaired driving. JAMA 1997;277:122–5.

Appendix: Studies Measuring the Effectiveness of 0.08% Blood Alcohol Concentration (BAC) Laws

Author & year (study period) Design suitability: design Quality of execution Evaluation setting	Study description[a] and other information	Results				
		Effect measure	Reported baseline	Reported effect	Value used in summary	Follow-up time
Research and Evaluation Associates 1991 (1986-1990)[1] Moderate: Time series Fair California	Law went into effect: Jan. 1, 1990 Comparison: Pre-law fatalities from crashes involving alcohol in California Note: Because .08 BAC and administrative license revocation laws were implemented within 6 months of each other, separate effects of each cannot be isolated	Fatalities from crashes involving drivers with BAC ≥0.01%	Pre-law mean = 225 fatalities/mo	-12% ($p < .01$)	- 12%	1 year
Rogers 1995 (1985-1993)[2] Moderate: Time series Fair California	Law went into effect: Jan. 1, 1990 Comparison: Pre-law fatal and severe injury crashes in California Note: Because .08 BAC and administrative license revocation laws were implemented within 6 months of each other, separate effects of each cannot be isolated	Single vehicle nighttime (8:00 PM-3:59 AM) fatal and severe injury crashes involving male drivers	Pre-law mean estimated from graph = ~190 crashes/mo	~ -7% (NS)	-7%	4 years
Foss 1998 (1991-1996)[3] Greatest: Before-after with concurrent comparison Fair North Carolina	Law went into effect: Oct. 3, 1993 Comparison: 1) Pre-law fatal crashes involving alcohol in North Carolina; 2) Fatal crashes involving alcohol in 37 states without 0.08% BAC laws Note: Some of post-law effect in NC may be attributable to the Booze-It-and-Lose-It sobriety checkpoint program (Nov. 1994 – July 1995)	Percent change in proportion of all fatal crashes involving drivers ≥21 years with BAC ≥0.10%	Pre-law proportion: NC = .228 37 comparison states = .238	Post-law proportion: NC = .183 37 comparison states = .207 NC vs. 37 comparison states: -6% (95% CI, -13%, +3%)	-6%	39 mos
Apsler 1999 (1982-1995)[4] Greatest: Time series with concurrent comparison Fair States: CA, FL, KS, ME, NH, NM, NC, OR UT, VT, VA	Laws went into effect: Aug. 1, 1983 to July 1, 1994 Comparison: Pre-law crashes involving alcohol	Ratio of fatal crashes involving a driver with BAC ≥0.10% vs. 0.00%	N/A	Coefficient of change in ratio of fatal crashes involving a driver with BAC ≥0.10% vs. 0.00% CA: -0.10, $p < .05$ FL: -0.15, $p < .05$ KS: -0.15, $p < .05$ ME: +0.09, NS NH: +0.16, NS NM: -0.36, $p < .05$ NC: -0.08, $p < .05$ OR: +0.60, NS UT: -0.09, NS VT: -0.48, $p < .05$ VA: -0.13, $p < .05$	Not used because coefficient cannot be transformed to percent change	1.5–12.4 years

Appendix Continued

Author & year (study period) Design suitability: design Quality of execution Evaluation setting	Study description[a] and other information	Results				
		Effect measure	Reported baseline	Reported effect	Value used in summary	Follow-up time
Hingson 2000 (1988-1998; varied by state, range 8 to 12 years)[5] Greatest: Before-after with concurrent comparison Fair States: FL, KS, NH, NM, NC, VA	Laws went into effect: July 1, 1993 to July 1, 1994 Comparisons: 1) Pre-law fatal crashes involving alcohol in study states 2) Fatal crashes involving alcohol in matched comparison states	Percent change in the proportion of all drivers in fatal crashes with BAC ≥0.10%	Pre-law proportion FL: .21 GA: .21 KS: .24 OK: .23 NH: .23 CT: .28 NM: .31 CO: .25 NC: .20 TN: .25 VA: .22 MD: .14	95% CI FL vs GA: - 7% (-14%, ±0%) KS vs OK: - 4% (-15%, +10%) NH vs CT: - 7% (-25%, +14%) NM vs CO: - 6% (-17%, +6%) NC vs TN: - 5% (-22%, +4%) VA vs MD: - 7% (-19%, +7%) Overall: - 6% (-10% , -2%)	FL: -7% KS: -4% NH: -7% NM: -6% NC: -5% VA: -7%	4–5 years
Hingson 1996 (1976-1991; varied, range from 3 to 15 years)[6] Greatest: Before-after with concurrent comparison Fair States: CA, ME, OR, UT, VT	Laws went into effect: Aug. 1, 1983 to July 1, 1990 Comparisons: 1) Pre-law fatalities among drivers with BAC ≥0.08% in study states 2) Fatalities among drivers with BAC ≥0.08% in matched comparison states Note: All study states and only one comparison state had administrative license revocation laws (authors estimate these accounted for ~5% of observed decreases in fatal crashes)	Percent change in the proportion of fatally injured drivers with BAC ≥0.08%	Pre-law proportion CA: 0.22 TX: 0.20 ME: 0.26 MA: 0.22 OR: 0.29 WA: 0.28 UT: 0.14 ID: 0.15 VT: 0.25 NH: 0.22	95% CI CA vs TX: -18% (-33%, -12%) ME vs MA: - 7% (-33%, +12%) OR vs WA: -18% (-25%, -11%) UT vs ID: -22% (-36%, - 5%) VT vs NH: +45% (-13%, +144%) Overall: -16% (-22%, -10%)	CA: -18% ME: -7% OR: -18% UT: -22% VT: +45%	2–8 years

Appendix Continued

Author & year (study period) Design suitability: design Quality of execution Evaluation setting	Study description[a] and other information	Results				
		Effect measure	Reported baseline	Reported effect	Value used in summary	Follow-up time
Scopatz 1998 (1976-1991; varied, range from 3 to 15 years)[7] Greatest: Before-after with concurrent comparison Fair States: CA, ME, OR, UT, VT	Laws went into effect: Aug. 1, 1983 to July 1, 1990 Comparisons: 1) Pre-law fatalities among drivers with BAC ≥0.08% in study states 2) Fatalities among drivers with BAC ≥0.08% in matched comparison states Note: This study is a re-analysis of Hingson 1996 study using different comparison states	Percent change in the proportion of fatally injured drivers with BAC ≥0.08%	Pre-law proportion CA: 0.22 AZ: 0.16 ME: 0.26 RI: 0.21 OR: 0.29 WY: 0.29 UT: 0.14 CO: 0.30 VT: 0.33 NY: 0.25	(CIs were not provided) CA vs AZ: +15% ME vs RI: -38% OR vs WY: -29% UT vs CO: +25% VT vs NY: -29% Overall: - 5%	CA: +15% ME: -38% OR: -29% UT: +25% VT: -29%	2–8 years
Johnson 1995 (1982-1992; varied) range from 3 to 4 years[8] Greatest: Before-after with concurrent comparison Fair States: CA, ME, OR, UT, VT	Laws went into effect: Aug. 1, 1983 to July 1, 1990 Comparison: Pre-law fatal crashes involving alcohol in study states	Percent change in proportion of all fatal crashes involving drivers ≥21 years with BAC ≥0.10%	Pre-law proportion CA: 0.246 ME: 0.219 OR: 0.341 UT: 0.198 VT: 0.336	CA: - 4%, p = .09 ME: + 1%, p = .10 OR: -11%, p = .06 UT: 0%, p = .90 VT: -31%, p = .04	CA: -4% ME: +1% OR: -11% UT: 0% VT: -31%	18–24 mos
Voas 2000 (1982-1997)[9] Greatest: Time series with concurrent comparison Fair 50 U.S. states and Washington, DC	Laws went into effect: Aug. 1, 1983 to July 2, 1997 Location: All 50 states and DC; 16 states had enacted 0.08% BAC laws by Dec. 1997 Comparisons: 1) Pre-law fatal crashes involving alcohol in 16 states that enacted 0.08% BAC laws by Dec. 1997 2) Fatal crashes involving alcohol in 34 states that did not enact 0.08% BAC laws by Dec. 1997	Change in the ratio of fatal crashes involving drivers ≥21 years with BACs ≥0.10% vs. 0.00%	N/A	-8.0% (95% CI, -3.4%, -12.4%)	-8.0%	0.5–14.4 years

Appendix Continued

[a] Each study analyzed information from police incident reports of motor vehicle crashes that occurred on public roads.

References

1. Research and Evaluation Associates. The effects following the implementation 0.08 BAC limit and an administrative per se law in California. Washington (DC): US Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis; 1991. Report No. DOT HS 807 777.

2. Rogers PN. The general deterrent impact of California's 0.08% blood alcohol concentration limit and administrative per se license suspension laws, Vol. 1. Sacramento (CA): California Department of Motor Vehicles, Research and Development Section; 1995. Report No. CAL-DMV-RSS-95-158.

3. Foss RD, Stewart JR, Reinfurt DW. Evaluation of the effects of North Carolina's 0.08% BAC law. Chapel Hill (NC): University of North Carolina Highway Safety Research Center; 1998.

4. Apsler R, Char AR, Harding WM, Klein TM. The effects of .08 BAC laws. Washington (DC): US Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis; 1999. Report No. DOT HS 808 892.

5. Hingson R, Heeren T, Winter M. Effects of recent 0.08% legal blood alcohol limits on fatal crash involvement. Inj Prev 2000;6:109-14.

6. Hingson R, Heeren T, Winter M. Lowering state legal blood alcohol limits to 0.08%: the effect on fatal motor vehicle crashes. Am J Public Health 1996;86:1297-99.

7. Scopatz RA. Methodological study of between-states comparisons, with particular application to .08% BAC law evaluation. Paper presented at the Transportation Research Board 77th annual meeting. Washington, DC, Jan. 11-15, 1998.

8. Johnson D, Fell J. The impact of lowering the illegal BAC limit to .08 in five states. 39th Annual Proceedings, Association for the Advancement of Automotive Medicine, October 16-18 1995, Chicago, Illinois. pp. 45-64.

9. Voas RB, Tippets AS, Fell J. The relationship of alcohol safety laws to drinking drivers in fatal crashes. Accid Anal Prev 2000;32:483-92.

Author Index

PII S0749-3797(01)00388-9

0749-3797/01/$–see front matter

PII S0749-3797(01)00387-7

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS MAIL PERMIT NO 6794 NEW YORK NY

POSTAGE WILL BE PAID BY ADDRESSEE

ELSEVIER SCIENCE
PO BOX 882
NEW YORK, NY 10160-0206

AFFIX POSTAGE HERE

ELSEVIER SCIENCE
PO BOX 882
NEW YORK, NY 10159-0882

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS MAIL PERMIT NO 6794 NEW YORK NY

POSTAGE WILL BE PAID BY ADDRESSEE

ELSEVIER SCIENCE
PO BOX 882
NEW YORK, NY 10160-0206

To subscribe to:

American Journal of Preventive Medicine

USE THE HANDY CARDS ATTACHED!

OR, FOR FASTER SERVICE,

CALL
212-633-3730

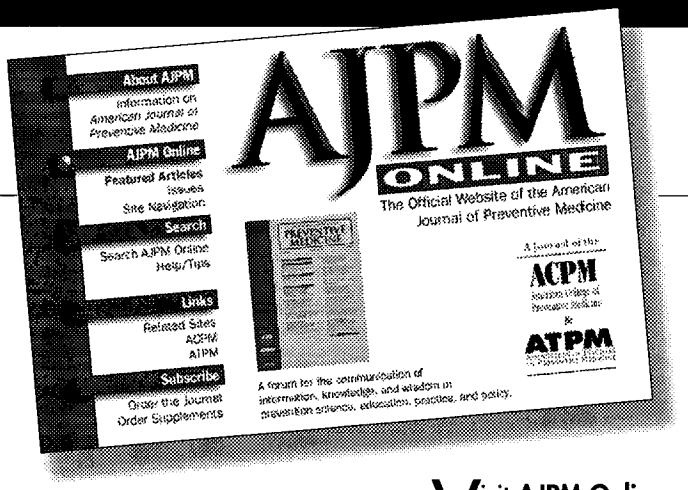
Toll-free in the U.S. and Canada:
1-888-437-4636

OR FAX
212-633-3680

For more information on Elsevier Science publications, contact our Home Page on the World Wide Web at:
http://www.elsevier.com

ELSEVIER SCIENCE

The latest in preventive medicine — now available online!



AJPM ONLINE

The Official Web Site of the *American Journal of Preventive Medicine*

Now!

The esteemed source of articles covering original prevention research, teaching, practice, and policy is instantly available on the Internet!

Visit **AJPM Online** at **http://www.elsevier.com/locate/ajpmonline** and you'll be able to

- view, download, and print Tables of Contents, abstracts, and full-length versions of two to three Featured Articles per issue
- search by author names, titles, or keywords
- find general information about the **American Journal of Preventive Medicine**, such as Instructions to Authors, ordering, and details on supplements
- link to related Web sites and Elsevier Science products of interest
- visit the Web sites of the **American College of Preventive Medicine (ACPM)** and the **Association of Teachers of Preventive Medicine (ATPM)**, the journal's two sponsoring organizations

On demand...

Imagine! 24-hour free access to essential preventive medicine research is just a click away.

Easy, powerful search capability...

Search Tables of Contents, abstracts, and selected full-length articles from the **American Journal of Preventive Medicine** by full-text, title, author, and MeSH heading fields.

ELSEVIER SCIENCE

Subscribe to AJPM today!

It's so easy. Just visit one of the following **AJPM Online** Web sites:

USA: **http://www.elsevier.com/locate/ajpmonline**

Europe: **http://www.elsevier.nl/locate/ajpmonline**

Japan: **http://www.elsevier.co.jp/locate/ajpmonline**

A9AJPMOL