Application of Behavior-Change Theories and Methods to Injury Prevention

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Abbreviation: HIV, human immunodeficiency virus.

INTRODUCTION

Reducing the burden of injury is an international health goal, one that requires an interdisciplinary perspective. Injuries, whether self-inflicted, inflicted by others, or unintentional, have one thing in common: They are largely preventable. Behaviors that give rise to violence and injury are amenable to preventive intervention, just as are many of the behaviors that give rise to diseases. Thus, behavioral science is an integral part of a comprehensive injury prevention strategy.

Applications of behavioral science to injury prevention lagged behind other approaches during the last half of the 20th century. Despite recognition by injury control professionals of the importance of behavioral research in injury prevention, behavioral solutions to preventing injury were deemphasized until recently (1, 2). Historically, little scholarly attention has been paid to understanding determinants of injury-related behaviors or how to initiate and sustain behavioral changes. Interventions often seemed to have been based on simplistic assumptions that changing people's awareness about the injury problem would change their behavior. Many authors have noted the need to improve behavioral interventions by using better empirical data about determinants of behavior as well as theories and frameworks pertaining to change in health behavior (3–6). A growing body of work is emerging that demonstrates the positive impact of using behavioral science approaches in order to both understand and reduce injury risk behaviors (6–10). In this paper, we describe the role of behavior change in injury prevention and illustrate how the application of selected behavior-change theories to injury problems, within the context of a health promotion framework, can contribute to the enhancement of injury prevention programs.

ROLE OF BEHAVIOR CHANGE IN INJURY PREVENTION

In planning for injury prevention and control, there has been a historical tension between the use of "active" (behavioral) strategies and "passive" (structural) strategies (1). The notion of passive protection arose from the great success of public health measures such as immunization and water fluoridation, which has been unparalleled. Passive approaches rely on changing products or environments to make them safer for all, irrespective of the behavior of individuals. Active approaches encourage or require people to take an active role in protecting themselves, despite hazards in their environments. Adding to the controversy has been the opinion of some that a focus on individual behavior could be interpreted as "blaming the victim" (11–14). However, in response to the victim-blaming assertion, it is also apparent that empowering individuals can lead to the political or social action necessary to achieve structural changes (6, 15).

Need for integrating passive and active strategies

It is rarely feasible to achieve injury reduction without some element of behavior change. In fact, while the structural intervention paradigm might seem straightforward, there is rarely an environmental change that does not require human adaptation. For every technologic advance, there are behavioral components that must be addressed. Children need to wear helmets while bicycling; parents need to correctly install child safety seats and booster seats; homeowners need to check their smoke alarms and change the batteries; parents with four-sided fences around their backyard pool need to ensure that the gate to the pool is always closed; occupants alerted by a smoke alarm still need to find their way to safety. Even the more passive approach to poison prevention through the use of child-resistant

closures—one of the great successes in injury control—requires active individual effort in replacing lids correctly (16, 17).

In road safety, for example, it is clear that behavioral countermeasures lagged behind the development of safer, more crashworthy vehicles, road engineering measures, and road safety education. However, it has been asserted that the failure of many early educational programs may have led to unwarranted conclusions that the use of behavior-change interventions for injury control is futile (17, 18). Lonero et al. point out that although weak and ineffective attempts to influence road safety behavior have led to widespread discouragement about the use of active safety measures, "effective and lasting modification of behavior is essential to effective road safety management" (19, p. 1). A recent example is the passive protection provided by passenger-side air bags. Once considered a panacea for injury prevention in crashes, the unexpected deaths of children and small adults from air bag deployment have resulted in a growing recognition of the need for education and behavioral change. Public health professionals are now educating parents to place children in the back seat, away from the passenger-side air bag, and educating drivers about air bag on-off switches so they remember to reactivate them when an adult is seated in the passenger compartment. We call this the active approach to passive protection.

The above examples underscore the necessity of combining behavioral and environmental approaches to injury prevention (6, 20–22). Green and Kreuter (23) and McGinnis et al. (24) have provided informative historical reviews that include many examples of improvements in population health that were achieved through a combination of educational and policy interventions focused on lifestyle changes. Successes in both tobacco control and motor vehicle safety in the United States also illustrate the point that an informed and supportive electorate facilitates the process by which legislative and other environmental strategies are adopted (25; L. W. Green et al., unpublished manuscript).

Need for new models

The complexity of injury problems demands complementary rather than competitive prevention strategies. Integration of knowledge about behavioral science into the mainstream of injury prevention research and practice will help researchers avoid the false dichotomy between active strategies and passive strategies and reduce the tendency to choose one over the other. The simplicity of early heuristics, such as the "three E's" model (engineering, education, and enforcement), may no longer be viable (19). Our understanding of injury is now more complex and dynamic. Even the Haddon model, which has guided the field into a long and fruitful period of countermeasure conceptualization, may need to be extended and enriched (19, 21, 26). According to Lonero et al., "While the [Haddon] model does not exclude behavioral factors, it fails to highlight them" (19, p. 3).

In Haddon's epidemiologic approach to injury, the host's role in injury reflects only personal risk at the level of the individual. Much of the research on behavior as it relates to injury has been on people whose behavior puts them at risk, such as the person who drinks too much alcohol and then drives (27). However, because so many of the effective injury countermeasures are policy-oriented in nature, it may be helpful to consider the host's role as an advocate for change in injury prevention at the community level (6). For example, Girasek et al. (28) found in a national survey that the public was generally unaware of the effectiveness of specific alcohol policies in reducing injuries, which may imply a need for injury control professionals to do a better job educating the public about prevention strategies other than individual risk reduction. Finding effective ways to activate the host to become an ally in efforts to make products and environments safer represents a new opportunity for behavioral science to contribute to injury prevention.

The creation of safer products and environments requires behavior change on the part of manufacturers of motor vehicles, toys, and other items that pose environmental hazards, as well as action by policy-makers who regulate exposure to hazards or mandate safety behaviors such as use of auto restraints (6, 29). Cataldo et al. emphasize this point with regard to childhood injury prevention: "Ultimately, injury control must entail some degree of behavior change, requiring the establishment and maintenance of appropriate safety behavior—by parents, legislators, judges and juries, police, health educators, physicians, reporters and the like" (30, p. 233). Below, we discuss theories and examples that can help facilitate the change process among persons at risk as well as among other audiences who influence policy and environmental change.

ROLE OF THEORY IN BEHAVIOR CHANGE

The limited success of behavior-change efforts in modifying injury-related behaviors can be traced, in part, to failure to fully understand the determinants of the behaviors and a failure to properly apply health behavior theory to the development and implementation of effective interventions. Glanz et al. (31) described theory as a set of interrelated propositions including concepts that describe, explain, or predict a phenomenon.

In this case, the phenomenon of interest is human behavior, specifically injury-related behavior (e.g., risk behavior, safety practices). Concepts or constructs are the component parts or "building blocks" of a particular theory (e.g., self-efficacy, social support, perceived susceptibility). Theories are important not simply because they help us understand causes of problems but because they also allow us to identify mechanisms of change, determine why programs succeed or fail, and, perhaps most importantly, guide us to build better prevention programs. Selection of the most appropriate theory is situation-specific and depends on the specific audience, the setting, and the characteristics of the behavior to be changed. A thorough discussion of the use and benefits of theory in health promotion research and program development is beyond the scope of this article, but interested readers are referred to several texts for more information (31–33).
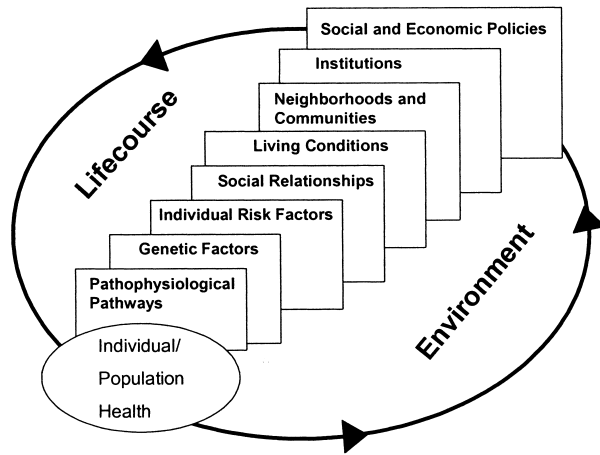
FIGURE 1. Multiple levels of influence on health. Reproduced with permission from Kaplan et al. (39).

New emphasis on ecologic models in public health

In the past few years, there has been growing national interest in the contributions of theoretical models from the behavioral sciences to public health. The Institute of Medicine of the US National Academy of Sciences recently commissioned two committees, one of which produced the report *Health and Behavior: The Interplay of Biological, Behavioral and Societal Influences* (34) and the other of which produced the report *Promoting Health: Intervention Strategies from Social and Behavioral Research* (35). Both documents emphasize the importance of taking an ecologic perspective. Together, these two documents offer a blueprint for social and behavioral science research in public health.

In 1998, the Centers for Disease Control and Prevention and the American Psychological Association cosponsored a national conference on integrating behavioral and social science with public health and subsequently published a book on the topic (36). Although only this latter document contained individual chapters on violence and unintentional injury prevention (6, 37, 38), there was consistency across all three reports (34–36) about the importance of an ecologic model in understanding and intervening in contemporary public health problems. The Institute of Medicine report *Promoting Health* stated, "Perhaps the most significant contribution of behavioral and social sciences to health research is the development of strong theoretical models for interventions" (35, p. 9). "The committee … found an emerging consensus that research and intervention efforts should be based on an ecological model" (35, p. 2).

The ecologic model states that health and well-being are affected by a dynamic interaction among biology, behavior, and the environment, and this interaction changes over the life course (39–41). This definition conveys the notion of multiple levels of influence on health (figure 1) and makes clear the importance of both individual-level and community-level factors in shaping health and health-related behaviors. According to McGinnis et al. (24), on a population basis, genetic predisposition accounts for approximately 30

percent of early deaths in the United States; social circumstances such as educational level, income, and social cohesion account for 15 percent; environmental exposures to toxic and microbial agents and structural hazards account for 5 percent; behavioral patterns such as lifestyle and safety practices account for 40 percent; and shortfalls in medical care account for 10 percent. Reductions in motor vehicle deaths and in tobacco use in the United States are examples of improved health outcomes that were achieved on a population basis through interventions at multiple levels of influence (25). Legislative policies, educational programs, and changes in the physical and social environment all contributed to changes in smoking and driving behaviors (i.e., restraint use, drunk driving), resulting in improved health outcomes (L. W. Green et al., unpublished manuscript). Thus, an ecologic model has utility in both describing influencing factors and developing prevention programs.

Levels of influence and intervention

In translating an ecologic model into action programs, Glanz and Rimer (42) describe three levels and the theories that are useful at each. First is the intrapersonal level, which refers to the influence of an individual's knowledge, attitudes, and beliefs on his or her behavior. Theories of cognition, perception, and motivation are relevant at the intrapersonal level. Second is the interpersonal level, which refers to how significant other people such as family members, friends, and coworkers influence an individual's behavior. Theories particularly relevant to interpersonal relationships include those related to social influence and social norms. The intra- and interpersonal levels are sometimes designated simply the "individual level." The third level is the community level, at which are considered organizational settings and their influences (e.g., workplaces, schools, churches), social and health policies (e.g., welfare reform), and other societal influences, such as poverty. Examples of models applied at the community level include community mobilization, organizational change, and intersectoral action. Institutions can influence individual behavior and community norms through expectations and sanctions. Macro-level societal policies can affect access to resources as well as sanction behaviors and shape community norms (24, 43). Patterns of community zoning and urban planning, for example, can dramatically affect the safety and health of communities and have an impact on behaviors ranging from youth violence and crime to physical activity, like walking and bicycling.

Theories and models can help explain community and individual change processes so that we are better able to facilitate and support changes in communities and among their residents. Different intervention strategies and methods are available for working with individuals and communities (44–46). For example, at the individual level, typical intervention strategies include a variety of behavioral, education, counseling, skill development, and training methods. Innovative new technologies such as computer-tailored messaging and behavioral prescriptions, Web-based learning, and motivational interviewing are promising approaches toward strengthening the impact of individual-level interventions

(47–49). When interventions focus on organizations, communities, and policies, the use of social marketing, mass media, and media advocacy are important, as well as coalition building, social planning, and community development (50–52).

APPLICATION OF THEORY TO INJURY PREVENTION

A complete enumeration of the theories used in the field of health behavior change to address other health problems is beyond the scope of this paper, although interested readers are referred to recently published textbooks (31, 33) and the Institute of Medicine reports (34, 35). Instead, we describe here several examples of well-respected behavior-change theories or models that have been applied to an injury problem. The extent to which behavior-change models have been applied to injury prevention has yet to be systematically reviewed, although such work is under way (4, 10, 53–55).

Individual-level theories and methods

The health belief model (56), the theory of reasoned action (57), the stages of change model (58), and applied behavioral analysis (30, 59) have an extensive body of literature supporting their utility, and each has been used for understanding an injury problem. Below, we briefly describe the key constructs of each of these models and provide an example of their application to an injury problem.

Health belief model. The health belief model states that preventive behaviors are a function of people's beliefs about their susceptibility to the health problem, the severity of the health problem, and the benefits versus costs of adopting the preventive behavior, as well as whether people experience a cue to action (56). In recent years, the concept of self-efficacy was added to the model. Self-efficacy, a concept originally taken from Bandura's work (60), is one's confidence in one's ability to perform a specific behavior. An illustration of the application of this model in injury prevention comes from Peterson et al.'s (61) study of the beliefs and safety practices of 198 parents with children aged 8–17 years. Peterson et al. used a variation of the health belief model to build formal predictions about how parents' attitudes would influence their injury prevention teaching and environmental modifications. Parents were generally not very worried about injuries to their child (i.e., low perceived susceptibility). The health belief model constructs most strongly associated with parental safety efforts were beliefs that their actions would be effective (i.e., benefits), a realistic appraisal of the costs of action (i.e., costs), and feeling knowledgeable about and competent to perform the behaviors (i.e., efficacy). These results can be used to target educational messages and strategies toward those variables associated with the desired behavioral outcomes. In this case, the authors suggested that interventions be directed toward increasing parents' belief in their child's susceptibility to injury while simultaneously increasing their competency to intervene. Health education methods and strategies for such interventions are widely available, and in this case might include direct communication via the mass media and smaller media to address the issue of susceptibility and skills training and access to needed safety products to address the issue of competence.

Theory of reasoned action. The theory of reasoned action characterizes behavior as a function of behavioral intention, subjective norms, and attitudes (57). The model says that people's intention to perform a behavior predicts their actual behavior. Intention is a function of attitudes and subjective norms. Attitudes are derived from measures of beliefs about the consequences of the behavior in question and the relative importance of these consequences to the individual. Subjective norms are derived from measures of beliefs about significant others' preferences and the individual's motivation to comply with their wishes. Ajzen (62) later modified the theory of reasoned action, calling the modified version the theory of planned behavior, and included the concept of perceived behavioral control, which reflects how easy or difficult the individual perceives the behavior to be. In 1984, the theory of reasoned action was used in a survey of parents' beliefs and practices regarding the use of car safety seats (63). A statewide random digit dialing survey of 406 parents of children aged 5 years or less was completed in an effort to obtain a better understanding of parents' use of car safety seats. The theory of reasoned action was used as the conceptual framework for the survey instrument. The construct of "attitude toward car-seat use" was found to be the single best variable for distinguishing between car-seat users and nonusers. This variable consisted of responses to six questions measuring beliefs about the consequences of the behavior (e.g., using a car seat would be a hassle; your child would be better behaved in a car seat). Respondents who believed that their spouse would approve of using a car seat (a measure of subjective norms) were also more likely to report using one. These results can help inform the development of public and patient education materials by identifying salient messages and credible sources for delivery of those messages. For example, media messages might communicate the ease with which car-seat use becomes a habit with positive consequences such as child comfort and spousal approval.

Stages of change. The stages of change model is a relatively newer model of behavior change. It is also called the transtheoretical model, because it incorporates constructs from several older models (58). This model is distinguished from the previous ones because it conceptualizes behavior change as a dynamic process rather than a static process, acknowledging that people differ in their readiness to change a behavior and that changes occur in discrete steps over time. There are typically five stages in this model: 1) precontemplative—not thinking about changing; 2) contemplative—aware and thinking about changing; 3) preparation—taking steps necessary for changing; 4) action—making the change for a short period of time; and 5) maintenance—successfully maintaining the change in behavior, usually measured as maintaining the change for 6 months or longer. This model includes the possibility of relapse to earlier stages, noting that maintained behavior change often occurs after a cyclical process of progressing and relapsing. The most obvious example of the utility of the stages of change model is the experience of many smokers who are trying to quit; and in fact, this model was developed from studies of how smokers

stopped smoking on their own. The stages of change model has been used to describe abusive men's ability to change their abusive behaviors (64) and to describe abused women's safety behaviors and ability to end their abuse (65, 66). In Burke et al.'s (66) qualitative study of women's descriptions of how they coped with and ended their abuse, there were clear examples of women moving from precontemplation (e.g., not considering their partner's behavior a problem, not labeling their experiences as abuse), to action (e.g., recognizing the abuse as a problem and taking some protective action, such as calling a shelter, contacting legal assistance, or moving out), to maintenance (e.g., having experienced no abuse or having been away from the partner for 6 months or more). The point of knowing what stage an individual is in with regard to a desired outcome is that it allows the interventionist to select and apply the most appropriate, stage-matched intervention. For example, to assist someone in moving from precontemplation to contemplation, strategies for raising awareness are recommended (e.g., distribution of information). Helping a person move from contemplation to the stages of preparation and action requires identifying and facilitating skills and access to the necessary resources.

Applied behavioral analysis. The term "applied behavioral analysis" identifies a specific subfield within psychology that uses the technology of behavior modification and operant conditioning to facilitate change. Behavior is viewed as learned, and principles of stimulus control, feedback, reinforcement, and punishment shape the acquisition, maintenance, and extinction of behavior (59). This model has a richer body of literature than the theories examined above. Multiple studies using applied behavioral analysis to address safety behaviors have produced fairly consistent and positive results. Application of these strategies in road safety interventions has effectively increased the use of safety belts (67–69) and child restraints (19, 30, 69), reduced vehicle speeding (70, 71), improved child pedestrian safety (72) and bicycle helmet use (4), reduced impaired driving (27), improved the safe driving practices of pizza deliverers (73), and reduced driver errors (74). In other areas relevant to injury prevention, applied behavioral analysis has been used to reduce children's fall-related behavior on playgrounds (75), improve fire escape behaviors and emergency response skills in the event of a residential fire (76–78), change safety behaviors during fires in public buildings (79), and modify other injury control behaviors (5, 9, 80).

Applied behavioral analysis seeks to understand and modify behavior by addressing the "ABCs" of behavior (antecedents, behavior, consequences). For example, in studying drinking and driving behavior, behaviorists are interested in analyzing: 1) antecedents to the behavior, such as cues in the environment, social pressure exerted by friends, or the practice of driving alone to a social function; 2) the behavior itself, such as frequency of drinking, size of the typical drink consumed, and amount of time between drinking and driving; and 3) the consequences that follow the behavior (both positive and negative), such as social attention or punishment for drinking and driving (27).

Understanding the ABCs that control a behavior can help the behaviorist intervene by shaping behavior and the environment to yield change. For example, removing roadside billboards that remind drivers of drinking, increasing the number of prompts and cues in the drinking environment that discourage drinking and driving, and encouraging the selection of a designated driver can be used to modify the antecedents. Slowing the rate of alcohol consumption, enhancing patron refusal skills, promoting server intervention in the drinking environment, and obtaining feedback from blood alcohol consumption meters can be used to modify the behavior. Social and peer support for not drinking and driving, positive feedback from bartenders or friends, and punishment for being caught drinking and driving can be used to modify consequences (9, 27, 81). This behavioral safety approach also has a strong history of use and success in promoting occupational health and safety (82), and it has been successfully applied to increase the use of personal protective devices such as hard hats and ear protection, to reduce injuries on the job, and to increase worker productivity and morale (83, 84).

These methods can be applied to change one person's behavior (such as a juvenile's fire-starting behavior), to change the behavior of a specific group at risk (such as factory workers), or to change the behavior of an entire community (such as the behavior of accessing emergency services by telephoning 911). Brief interventions in counseling/feedback sessions, together with the application of sound behavior modification strategies, have also been successfully used to change injury-related risk behaviors and the risk of reinjury (49, 85, 86). However, the target audience is not limited to persons at risk. These approaches may also be usefully applied to modifying the behavior of parents, legislators, medical personnel, managers, inventors, policy-makers, and enforcers whose behavior influences large segments of the public (8).

Integrating models at the individual level. The paucity of behavioral theories and models pertaining to injury problems is a dilemma similar to the one that was faced by health practitioners attempting to respond to the human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome crisis in the 1980s. At that time, the lack of attention to theory often led to the implementation of ineffective prevention programs in response to the pressing need for behavior modification among persons at greatest risk for HIV infection (87, 88). We can draw lessons from this early experience with HIV that may help in shaping behavioral interventions for injury control.

In 1991, the National Institute of Mental Health convened a theorists' workshop that brought together creators of behavioral theory to develop a unifying framework for applying behavioral theory to the prevention of HIV infection and acquired immunodeficiency syndrome (89). The discussions led to the enumeration of five theories that, taken together, contain virtually all of the variables that have been utilized in attempts to understand and change a wide variety of human behaviors: the health belief model (56), the social cognitive theory (60), the theory of reasoned action (57), the theory of self-regulation and self-control (90), and the theory of subjective culture and interpersonal relations (91). When all five theories and their many variables had been considered, consensus was reached on eight factors that appear to account for most of the variation in health-related behaviors:

1) intentions, 2) environmental barriers, 3) skills, 4) outcome expectancies (or attitude), 5) social norms, 6) self-standards, 7) emotional reactions, and 8) self-efficacy. These same eight factors might also regulate and predict change in injury risk behavior (Dr. Martin Fishbein, University of Pennsylvania, personal communication, 2003).

Translating this guidance into action, Fishbein et al. (92, 93) concluded that, generally speaking, in order for a person to perform a given behavior, one or more of the following must be present:

1. The person forms a strong positive intention or makes a commitment to perform the behavior.
2. There are no environmental barriers that make it *impossible* to perform the behavior.
3. The person possesses the skills necessary to perform the behavior.
4. The person believes that the advantages of performing the behavior outweigh the disadvantages.
5. The person perceives more normative pressure to perform the behavior than to not perform it.
6. The person perceives that performance of the behavior is consistent with his or her self-image or values.
7. The person's emotional reaction to performing the behavior is more positive than negative.
8. The person perceives that he or she has the capabilities to perform the behavior under different circumstances.

The first three factors are viewed as necessary and sufficient for producing any behavior, while the remaining five are viewed as modifying variables influencing the strength and direction of intentions. By way of a hypothetical example, we can apply these notions to a specific injury control behavior: testing the functionality of a residential smoke alarm. If a homeowner is committed to testing the smoke alarm every month, has access to the smoke alarm, and has the skills necessary to successfully test the alarm, we can predict that there is a high probability he or she will perform the behavior. The probability that the individual will test his or her smoke alarm monthly would be predicted to increase even more if the homeowner also believes that testing is worth the time and trouble, knows that his/her neighbors all test their alarms, believes that testing is consistent with his/her values as a responsible homeowner, has no negative emotional reaction to testing, and can test the alarm under different conditions in the home. Under these conditions, the probability of the homeowner's testing the alarm monthly would be predicted to reach nearly 1.0. To date, this integrated model has not been applied to this or any other injury-related behavior, but it holds promise as an innovative approach. We are just beginning to adapt and integrate models such as these at the individual level for injury prevention behavior, and more work is needed to design, test, and evaluate interventions based on these behavioral models.

Community-level theories and methods

Community organization. The community organization approach focuses on the active participation and development of communities to enable them to better evaluate and solve health and social problems (51). Bracht et al. define community organization as purposeful effort to "activate a community to use its own social structures and any available resources that are decided on primarily by community representatives and that are generally consistent with local values" (52, p. 86) in order to accomplish community goals. Early commentaries on the importance of community interventions in injury control described the difference between "community-wide" interventions and "community-based" programs (94), and it was suggested that the effectiveness of community-wide programs could be enhanced by treating the community "as the source and not simply the site" of prevention programs (95).

One example of a successful community organization effort in injury control is the Injury Free Coalition for Kids initiative, which started with the Harlem Hospital Injury Prevention Program in New York City (96, 97). In the mid-1980s, injury surveillance was used to identify the causes of injury to children and adolescents living in the low-income neighborhoods surrounding Harlem Hospital. In response to compelling evidence of an injury problem, a multidisciplinary lay-professional coalition was formed to develop and implement prevention programs, which included new educational programs, safe play areas, and supervised activities for children. Some of the specific program components were playground renovations; a Safety City, where children are given safety lessons; window guard legislation for high-rise apartments; art, dance, and sports programs; and free bicycle helmets. From 1983 to 1995, hospital admissions due to injury decreased by 55 percent overall, by 46 percent for pedestrian injuries, by 50 percent for playground injuries, and by 46 percent for violence-related injuries (98). Although the total number of injuries also declined in the comparison community, the declines in the intervention community were most noticeable for the specific injuries and age groups targeted by the program (96).

Community moblization. The term "community mobilization" has been used to refer to efforts to involve community members in activities ranging from defining prevention needs to obtaining community support for a predesigned prevention program (99). Community mobilization emphasizes changing the social and economic structures that influence injury risk. Treno and Holder (99) noted that mobilization can include elements of both "bottom-up" (or grassroots) and "top-down" (leader-initiated) strategies, the difference being who defines the problems and who decides on solutions. In the former, it is the community members themselves, and in the latter it is an outside expert (an external or self-appointed community leader). According to these authors, there are limitations to using either strategy exclusively. Grassroots involvement is essential, but it may not be sufficient if, for example, community organizations have competing priorities or lack expertise in defining effective interventions. Alternatively, top-down approaches may have limited sustainability if community organizations and leaders are not supportive and engaged (99). Because community leaders understand their local culture, politics, and traditions better than outsiders, their participation is essential for tailoring imported prevention programs to local needs. The balance between bottom-up and top-down

approaches can be situation-specific, as Green noted in his reflections on the contributions of health education to public health: "Community is, ideally, a level of collective decision-making appropriate to the urgency and magnitude of the problem, the cost and technical complexity of the solutions required, the culture and traditions of shared decision-making, and the sensitivity and consequences of the actions required of people after the decision is made" (100, p. 82).

In Treno and Holder's Community Trials Project, mobilization was defined as "the purposeful organization of community members to implement and support policies that will reduce alcohol-involved trauma" (99, p. S175), and a community-science partnership was formed. The overarching conceptualization of how this project addressed the alcohol-injury connection was environmental; it focused on "changes in the social and structural contexts of alcohol use that can alter individual behavior" (101, p. S161). Prevention policies and activities that were to be implemented were those supported by research evidence, and communities were asked to customize and prioritize their initiatives depending on local concerns and interests. Specific components of the mobilization effort were directed toward responsible beverage service, drinking and driving, underage drinking, and alcohol access. Coalitions, task forces, and media advocacy were used to raise awareness and support for effective policies among the public and relevant decision-makers (101). In an evaluation of the impact of the mobilization efforts, Holder et al. (102) compared intervention communities with control communities and demonstrated significant reductions in the following indicators: 6 percent in the reported quantity of alcohol consumed; 51 percent in driving with a blood alcohol level over the legal limit; 10 percent in nighttime injury crashes; 6 percent in alcohol-related crashes; and 43 percent in alcohol-related assault injuries seen in emergency departments.

Empowerment. The concept of empowerment was demonstrated in these programs through their use of coalitions and task forces to foster community ownership and participatory problem-solving (51). Principles that are derived from a community organization model and are reflected by the experience of the Harlem program and the alcohol and trauma program include the principles of participation and relevance (23). The principle of participation states that behavior change will be greatest when those whose behaviors or circumstances are to be changed are directly involved in intervention planning and decision-making, and the principle of relevance states that change will be greatest when community organizers "start where the people are" and engage community members for their knowledge of what matters to the population at risk. By working with coalitions and task forces and supporting community tailoring of program components, the organizers observed both of these principles.

Community-based participatory research. These examples also provide compelling support for another relatively new movement in public health research and practice: community-based participatory research (103, 104). While participatory research is increasingly being advocated for dealing with a multitude of public health problems, it is perhaps especially important for problems that relate to indi-
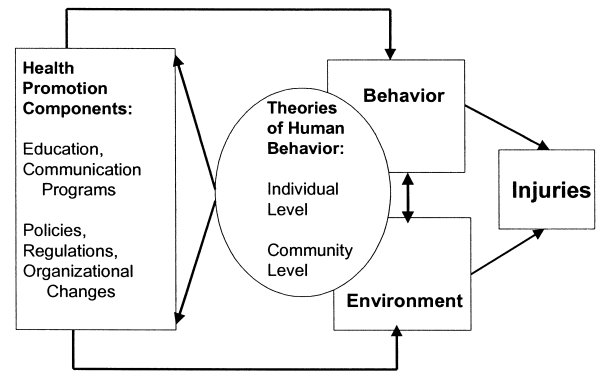

FIGURE 2. Health promotion framework for injury prevention. Adapted from Green and Kreuter (23).

vidual behavior. Implementation and evaluation of policies and programs that attempt to change personal behavior requires extreme sensitivity to the ethical issues surrounding the protection of individual autonomy. By engaging our communities in needs assessment and decision-making about program design and evaluation, which is at the heart of community-based participatory research, we are more likely to adopt strategies that are consistent with the core values of the community and society.

THE HEALTH PROMOTION FRAMEWORK

The use of behavioral and social sciences to achieve the goals of health promotion has had a long tradition in public health and a strong base in theory and practice (15). Injury prevention can benefit from this legacy. Translating health behavior theories and models into action programs is essential for injury prevention. The health promotion framework of Green and Kreuter (23) is derived from an ecologic model and assists in this translation process. A health promotion approach is particularly useful for injury prevention because it specifically facilitates both behavioral and environmental change. Health promotion includes "the combination of educational and environmental supports for actions and conditions of living conducive to health" (23, p. 14). This widely recognized definition acknowledges the importance of taking behavioral, environmental, *and* policy approaches to the prevention of injury. The conditions of living that health promotion interventions seek to change are those social and environmental factors that influence injury-related behaviors and give rise to injury. Individual and community actions fostered by education, stimulated by social norms, and encouraged through public policy are the immediate objectives of a health promotion approach to injury prevention (20, 105). Theories provide the bridge from understanding which behaviors and environmental factors are responsible for an injury problem to deciding on and developing appropriate interventions (figure 2). This approach is clearly consistent with the position that effective injury prevention programs must utilize interventions that change environments and products as well as individuals and communities.

In support of the health promotion approach, we are reminded by Mason and Tolsma that "persons can hardly be expected to avoid the risks imposed by personal choices when they do not know or understand these risks, when they lack the knowledge or skills needed to choose a healthier lifestyle, or worst of all, when they seek guidance or support from their community and it is unavailable to them" (106, p. 772). These are conditions that favor a health promotion approach. In injury prevention, perhaps more than with other health problems, there is a strong need for community support, obviously necessary for legislative initiatives but equally important for personal safety behaviors. For example, convenient access to reasonably priced safety products has been repeatedly described as a necessary component of injury prevention programs focused on such issues as car safety seat use, bicycle helmet use, and home safety for children (107, 108). Towner et al. concluded from their systematic review of injury prevention interventions for children and young adults that what is needed is the synergism resulting from the use of "a variety of approaches including education and training, accessible protective devices and safety equipment, environmental change and legislation and its enforcement" (109, p. 97). This is the health promotion approach to injury prevention. Theories pertaining to the individual and community levels should help in clarifying assumptions on which interventions are selected, and when used in conjunction with thorough needs assessments, they should contribute to the building of comprehensive injury prevention programs. Behavior-change theories and methods have become integral to much of health promotion, and they can be beneficially applied to the modification of both individual and social or environmental factors that influence injury risk.

CONCLUSIONS

A significant behavioral science knowledge base about how to promote individual and community health has developed over the past half century, and it is relevant to injury prevention and control (31–36). However, the behavior-change theories and methods that have been successful in addressing other public health problems have been underrepresented in the injury literature (10, 55), and their application has been underfunded by government agencies and private donors (2, 110). Because academic research in behavioral science is just beginning to address injury issues, more time will be needed to realize the full potential of its contributions to injury prevention and control.

Much is currently being done to facilitate behavioral science research in this field. For example, the Centers for Disease Control and Prevention recently released requests for proposals related to theory-based approaches to injury prevention, and the agency actively promotes research into behavioral safety (111). In 2001, the Centers for Disease Control and Prevention provided funds to each of its 10 injury control research centers to conduct training and research specifically related to behavioral science and injury prevention. The theme of the American Psychological Association's 2001 initiative "Psychology Builds a Healthy World" focused on the opportunity to improve health *and*

prevent injury through the contributions of psychology. The initiative presents new opportunities and new challenges to psychologists to apply their tools, skills, and concepts to injury prevention. Proceedings of the initiative will soon be released in a textbook (112). At the 2002 World Conference on Injury Prevention and Control in Montreal, Canada, a special session on integrating behavioral sciences into injury and violence prevention was held for the first time (55). The session was well attended and generated scholarly discussion of needs and future directions. A similar session is planned for the 2004 conference in Vienna, Austria.

Training workshops on behavioral approaches to injury prevention and control have recently been held under the sponsorship of the Centers for Disease Control and Prevention (53) and in collaboration with the Harborview Injury Prevention and Research Center (54). The National Science Foundation held a workshop on risk analysis and decision-making in 2002, with implications for injury control (113), and major initiatives are under way at the National Institutes of Health to promote behavior-change research in the Office of Behavioral and Social Science Research (114).

Special issues of scholarly journals have been devoted to behavioral and health promotion aspects of injury and violence prevention (8, 73, 115–117). Systematic reviews of prevention strategies have highlighted the need for more effective educational approaches and behavioral change applications to injury control (49, 107, 118).

As behavioral scientists have become more involved in research in public health, there has been greater general acceptance of their contributions (119, 120). Behavioral scientists can complement the work of epidemiologists and other public health practitioners working on injury problems in health care settings, schools, workplaces, and communities. Use of behavior-change theory and methods should also facilitate change among the people who make laws and design products, such as legislators and engineers, in ways that can ultimately protect entire populations.

FUTURE NEEDS

To further advance the contributions of the behavioral sciences in injury prevention, more attention should be paid to issues of training, research, and practice. Training more behavioral scientists in the epidemiology of injury and the science of injury control is an urgent first step. Likewise, enhancing the behavioral science training of public health students focusing on injury control is essential. Key injury research areas that would benefit from behavioral science investigation include: foundational research on psychological and behavioral aspects of child supervision; the psychology of evacuation; motivating people to engage in personal protective behaviors; applying behavior-change theory to injury prevention interventions; communications and diffusion research to increase the acceptance of effective interventions; theoretical research to clarify the mechanisms by which change occurs across levels of ecologic models; applied research to understand and modify risk perceptions, social norms, and other psychosocial factors associated with behavior and behavior change; developmental research addressing child and adolescent injuries; and intervention

research on psychological factors in human trauma and rehabilitation. Many of these research themes are consistent with recent federal government funding priorities, as described in the Centers for Disease Control and Prevention research agenda on injury prevention (111). In the practice arena, there is a need for partnerships with academic researchers to enhance the applicability of research to practice and vice versa, as well as to increase the use of community-based participatory research methods and behavioral epidemiology in injury prevention and control. We believe these are important steps for strengthening the application of behavioral science to injury control, which in turn can contribute to changing individual behaviors, environmental conditions, and social structures to prevent injuries.

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