Using the Data 5

Chapters 3 and 4 of this report are compilations of information about health and safety risks in school. This chapter discusses how these data—along with other types of information—can help set priorities for risk reduction. In the end, surveys and studies of illness, injury, and death can provide only part of the picture. Decisionmakers are still faced with questions of which risks can be remediated and at what cost.

Moreover, even with good health and safety data (uncommon) and good information about the effectiveness and costs of risk reduction measures (even less common), the decision about which risks to focus on first would not be straightforward. These decisions go well beyond counts of illness and injury and costs of improvements, to difficult ethical, social, and emotional choices.

Inevitably, the course of deciding which risks matter the most leads to suggestions for the use of comparative risk assessment (CRA). Following a discussion of the different risk-related concerns, this chapter briefly explains CRA and the opportunities and problems it presents for making risk comparisons and deciding on priorities for risk reduction.

RISK DIMENSIONS

What is presently called "risk comparison" usually compares the number of injuries, illnesses, or deaths each risk may cause, without any other factor distinguishing them. Risk estimates alone do not necessarily relay the entire picture concerning the health effects involved, such as information on the nature of the death, illness, or injury, and the costs involved (13). The challenge for analysts is to present quite varied risks in rich, informative, and nonmanipulative ways. The starting point for broadening the scope consists of a fuller enumeration of the attributes or dimensions of risk.

It is natural for most people to order things by their size or severity, yet simple point estimates of risk often do not convey how risks, even of similar numbers of deaths, illnesses, or injuries, can differ. As an illustration of the importance of risk attributes beyond magnitude, consider the data presented in chapter 3 on deaths to students from school bus crashes and from in-school homicides. In both cases the severity is the same and the number of annual fatalities is roughly equivalent (40 to 50 cases in recent years). Nevertheless, there can be no doubt as to which cause of death is presently of greater public concern: school homicides. One indication of this public

concern is the number of bills appearing before Congress on these issues. The 103d Congress introduced 61 bills dealing specifically with school violence and only two on school bus safety—of which one was a resolution for a "school bus safety week." Clearly, setting priorities involves more factors than just the number and severity of injury or illness.

This report discusses those risk attributes that can be considered in efforts to compare and rank diverse in-school risks, which inevitably involves value judgments as well as scientific estimates and measurements. It organizes the relevant risk attributes, or "dimensions," into three categories: magnitude of the risk; fear; and social contexts of the hazard (table 5-1).

The risk magnitude refers to the quantitative estimates of the likelihood of adverse health effects arising from the hazardous conditions. This category reflects the more conventional notions of the number of cases of injury and illness and their severity. There are several common measures for quantifying risk magnitude, some of which measure the individual probability of risk or the risk to the population. This report uses the number of incidents and incidence rates as measures of injury or illness in the school population and lost school days as a measure of severity. One measure of particular relevance in this report is in not treating all fatalities as equal; instead, the death of a child can be weighted more heavily than that of an adult, accounting for the additional years of life lost for the child.

Fear can be one of the most significant dimensions of risk, especially in schools, and one that varies widely across individuals and communities. Contributing to the fear of a hazard is the extent to which individuals can or cannot control the risk through personal action. Parents may fear their child's in-school exposure to asbestos or students carrying weapons because they cannot control these things, but they are probably less afraid of the exposures to infectious pathogens—even though bacteria and viruses are responsible for more lost school days—because they have more control from antibiotics, vaccines, and bedrest. The irreversibility

TABLE 5-1: The Dimensions of Risk

Category I: Magnitude

- Unweighted population-based measures of magnitude.
- Weighted population-based measures.
- Individual-risk measures that are independent of the number of persons at risk.
- Hybrid measures that incorporate characteristics of both population and individual-risk criteria.
- Measures that incorporate the concept of "background."

Category II: Fear

- Degree of fear.
- Degree of irreversibility.
- Degree of individual controllability.
- Degree of deferral to future generations.

Category III: Social Contexts of the Hazard

- Salience of blame.
- Degree of identifiability of those at risk.
- Benefits of the risky activity or exposure.
- Cost and feasibility of reducing risk.
- Risks of the intervention itself.

SOURCE: A. Finkel, "Comparing Risks Thoughtfully," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, September 1994.

of an illness or injury also adds to the fear associated with a hazard; the more irreversible the effect, such as spinal cord injury or HIV infection, the greater the fear.

In contrast to magnitude, much of the social context of different risks cannot be readily quantified. Some risks are more worth taking—or bearing—than others. This difference is largely governed by the perceived benefits that accompany the risk. Football, for example, is among the most hazardous athletic activities—in terms of the number and severity of injuries—in which high school students participate; yet the perceived benefits of athletic accomplishment and social recognition encourage continued participation in it. The risk of a student dying in a car crash on the way to and from school may be high, but the risks are offset by the considerable time saved or the risks averted from having to walk home in the dark.

Analysts and decisionmakers must also consider impacts other than health, such as the disruption of the learning process that occurs from lost school days. One study found that absenteeism can present a social hazard, in terms of maladaptive behavior, difficulties in finding and maintaining employment, and welfare costs (20). Another intangible factor is the desire to focus attention on reducing risks where in so doing injustices can also be redressed and blame for the hazard can be affixed. Toxic releases from nearby hazardous waste sites or industry discharge generate more attention than comparable or even greater risks from radon because, in part, radon, unlike toxic releases, where a culpable polluter can usually be identified, is a natural gas and no one is responsible for its generation or its presence in indoor air.

The last category of risk attributes is an especially important consideration now confronting schools: the cost and feasibility of reducing risks. Small risks that are cheap and easy to eliminate may deserve priority attention, whereas even very large risks may not emerge as priorities from a thorough risk comparison—if reducing them would be technically infeasible or prohibitively expensive. Metal detectors, for instance, may provide added protection from firearms in schools, but they are expensive and school boards must decide if the risks at their schools justify the costs. Not only the cost, but the risk of the intervention itself, the dimension of "offsetting or substitution risks," arises whenever reducing one risk would create new risks in so doing. For example, closing the schools to remove asbestos exposes the children to risks of being out of school.

COMPARING RISKS

Risk comparisons are ubiquitous. Even though the most well-known types of comparisons involve environmental and human health risks, it is important to keep in mind that everyone has experience comparing many other risks as well. People may fear airplane travel and instead opt for travel by car—even though the risks of the latter are far greater. Some may fear bacterial contamination of fish and poultry or pesticides in their salads, yet are unconcerned about smoking cigarettes or drinking alcohol before driving.

To provide a context for the use of the data presented in this report, this section describes different types of comparative risk assessments, ways to conduct those assessments and, finally, factors to consider when setting priorities for risk reduction.

Types of Comparative Risk Assessments

Some analysts distinguish between two different types of comparisons that differ in motivation as well as methodology.[1] These comparisons can be called "small" and "large" CRA paradigms. "Small" CRA involves the quantitative side-by-side comparison of single risks. Ten or 15 years

[1] See A.M. Finkel and D. Golding (eds.), *Worst Things First? The Debate Over Risk-Based National Environmental Priorities* (Washington, DC: Resources for the Future/Johns Hopkins Press, 1994).

ago, the most well-known examples of "small" CRA were the juxtaposition of markedly dissimilar risks, often with one risk of the pair a voluntary risk and the other the result of an involuntary exposure. Such "hang-gliding is riskier than benzene comparisons" were performed and popularized for their supposed value in communication and public education (2). Some, however, viewed this type of analysis as manipulative and grounded in numerical sleight-of-hand rather than a neutral desire to inform and help put risks in perspective (3,14). In any case, the acknowledged intention of these efforts is to provide the perspective on a given risk with a comparison with others risks encountered in everyday life (see box 5-1).

Other types of "small" CRA are entering into current decisionmaking. The U.S. Environmental Protective Agency has recently begun to compare risks closely linked to intended regulatory actions; for example, the comparison of health risks of various automotive fuels and the ongoing assessment of the choice between cancer risks caused by the chlorination of drinking water and pathogenic risks due to the failure to disinfect.

"Large" CRA is a more recent phenomenon. It involves the comparison of categories of risks, and is increasingly being undertaken both for symbolic and practical purposes. The most prominent examples of "large" CRA have come from EPA's 1987 report "Unfinished Business" (18) and its 1990 study "Reducing Risks: Setting Priorities and Strategies for Environmental Protection" (19). Both reports explored whether setting agency priorities using, in part, a risk-based approach would save more lives and provide better protection without increasing the agency's total budget.

Many state and local governments are experimenting with CRA in ranking environmental problems by severity and comparing risk-reduction strategies. As discussed in box 5-1, at least

BOX 5-1: Comparing Risks in the States

At least 30 city, state, and tribal CRA projects are completed, under way, or in the planning stages. These efforts attempt to rank risks and priorities for environmental problems by incorporating qualitative information and value-laden judgments. Various experts in different environmental health fields provide their qualitative estimates of risk, but these estimates are broadened and enriched by public involvement. These studies are part of a nationwide effort by the U.S. EPA to help regulatory agencies in each state identify their most pressing environmental risks. The idea is to help cash-strapped states cope with growing federal environmental legislation and regulations by making it easier to compare the costs and benefits of proposed regulations to existing rules.

Comparative risk analysis deals with the full range of environmental problems and in large areas. It depends heavily on qualitative information and value-laden judgment in addition to the estimates of the magnitude of risk. Comparative risk analysis is a process that can be divided into two phases: risk analysis and risk management. In the analytic phase, participants try to understand how environmental problems affect the things they value, such as health or environmental quality. The first phase ends when participants rank the problems in order of their severity.

In the second phase, participants analyze and compare strategies for better addressing the problems they find are important. Most projects use an open process designed to bring the public into both the analytic design of the projects and the decisionmaking itself.

The ranking process is the key event in the first phase of a comparative risk project because it forces participants to make sense of all they have learned about the causes and consequences of pollution, the distribution of risk, and the quality of data and the uncertainties inherent in risk assessments. Although comparing dissimilar risks is not a technical or scientific process, the framework of comparative risk makes the process systematic, thoughtful, and illuminating.

SOURCES: Office of Technology Assessment, 1995, based on R. Stone, "California Report Sets Standard for Comparing Risks," *Science* 266:214, 1994, and R. Minard, "Comparative Risk Analysis," testimony presented at hearings before the Subcommittee on Technology, Environment, and Aviation. Committee on Public Works and Transportation, House of Representatives, U.S. Congress, Washington, DC, February 3, 1994.

30 city, state, and tribal CRA projects are completed, under way, or in the planning stages (11,16) (figure 5-l). These efforts attempt to rank risks and priorities for environmental problems by incorporating qualitative information and value-laden judgments. Various experts in different environmental health fields provide their qualitative estimates of risk, but these estimates are broadened and enriched by public involvement.

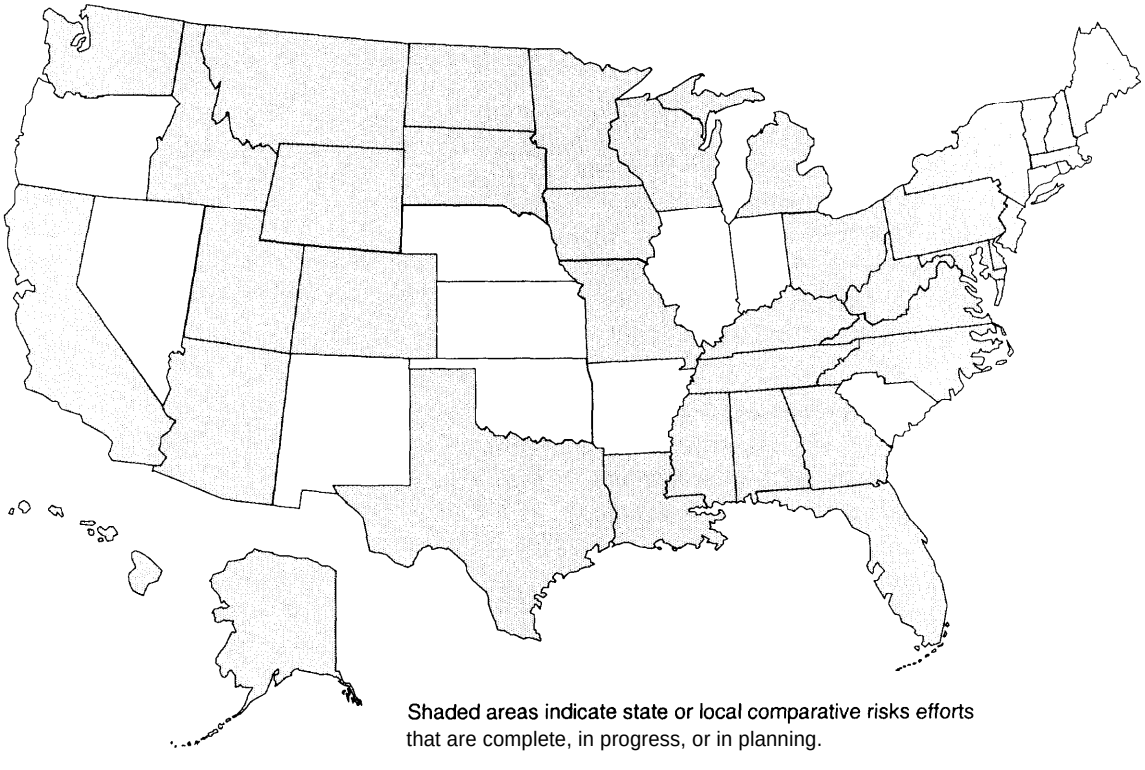
Conducting Risk Assessments

Whatever process society chooses for putting comparative risk assessment into practice, it ought to advance two distinct goals: provide a forum for identifying, and making judgments about, the "important" dimensions of the risks being compared, and provide a framework for asking, and moving towards consensus about, the real underlying question: "What should we do to make our schools safer, given that any intervention we undertake will use up resources from a finite supply?"

Much of the current discussion of the process for comparing risks revolves around the distinctions between the so-called "hard" version of risk-based priority setting and the "soft" version preferred by some other stakeholders (3,4). The design of the "hard" version—also referred to as "expert-judgment"- involves the use of a small group of experts to develop estimates of the magnitude of various risks, as well as a ranking of risk reduction opportunities. This strategy presumes that the experts can estimate the "actual risk" that will be different than the "perceived risk" of the lay public (15).

Some believe that the hard version can do more harm than good. Certainly, confining the ranking process to the experts, and further cir-

FIGURE 5-1: Comparative Risk in the States



Shaded areas indicate state or local comparative risks efforts that are complete, in progress, or in planning.

cumscribing it to deal only in the currency of "risk numbers," may not be productive in advancing social judgments on risks in schools, for two overriding reasons: 1) the conventional ranking tool—using risk estimates—is one-dimensional: many other dimensions may be of equal or greater importance than risk magnitude alone; and 2) even if magnitude is the most important dimension, exclusion from the process to determine the ranking will tend to cause resentment and mistrust among the affected citizens, in this case parents and their children (3,7).

The soft version has its problems too. In this paradigm, a representative group composed of citizens and experts would work together to generate a more impressionistic and less quantitative, magnitude-oriented ranking from a consensual weighting of the various dimensions that distinguish the risks under consideration. In this way the views and values held by those in the community can be incorporated into the risk-ranking activity. The obvious objection to the softening of CRA is that it allows people to make the subjective, soft dimensions, such as fear, as important—if not more so—than the quantitative information on risk estimates. From its critics' point of view, the soft version is just a polite way to describe the emotional, haphazard, inefficient way we currently set priorities. A perhaps less obvious but potentially more damaging criticism points out an irony—that while the soft version serves as a model alternative to the technocratic elitism of the hard approach, it may be no less vulnerable to being dominated by special interests (10).

For all the criticism, supporters of CRA argue that it is a logical extension of the less formal thought process individuals and governments already rely upon to help them make choices in all areas of human endeavor (3). Comparison and ranking inevitably involve value judgments as well as scientific measurements and estimates. One study suggests that qualitative characteristics of perceived risk are important to people in making decisions about new technologies (8). An open process, supporters claim, informs risk assessors about the values of those affected and the importance they place on these subjective risk attributes. Moreover, they claim that even if a CRA fails in establishing priorities, the effort would succeed in both educating and involving the public, engendering more public support for resulting decisions (17). As Fischoff states, "an objective determination of subjective values is needed to protect individuals from being exploited by society and society from being coerced by individuals" (6).

Lessons Learned

Regardless of the nature of the evaluative strategy, hard or soft, certain lessons can be learned from the limited attempts at CRA currently being conducted by local, state, and tribal governments. Few hard and fast conclusions can be drawn until more experience has been gained. Nevertheless, these CRA experiments reveal certain desirable features for CRAs.

The first lesson is to significantly involve the public. Public participation has proven an invaluable aspect of CRAs. By involving the public, a CRA can go beyond probability estimates of risk and incorporate ethical and political concerns, which are usually neglected in risk assessments (6,15). An open process informs risk assessors about the values and importance of subjective risk attributes, such as fear, to the community. Comparison and ranking inevitably involve incorporating these value judgments as well as scientific estimates and measurements.

The process also educates the public on the scientific and technical issues associated with risk assessment. The process should instruct everyone involved—parents, school boards, risk assessors, and others—about the nature of suspected risks. Risk comparisons can alienate people if the comparisons fail to inform them (5).

The next lesson is the need for a strong analysis of the available risk information and clear criteria for comparisons. The methods used by states and EPA (1,11) for risk analysis employ teams of experts to fashion a list of problems, sorted by types of risk—cancer, noncancer, ecological effects, etc. Using a variety of standards

for comparison, the experts can first rank the problems within each type of risk and then relative to hazards of other types. The initial information that flows from these analysts to the public should be regarded as the first step. In addition to having a central role to play in evaluating the empirical and narrative information about the various dimensions of the risks being compared, the stakeholders may have much to contribute in structuring the criteria of analysis and supplementing the information itself. Having all participants agree to a common set of criteria and basing the analysis on those criteria make the results more understandable, as well as politically and socially acceptable.

The major obstacles to successful CRA projects come from the resource- and information-intensive nature of the process. Undertaking a CRA in a school district or state requires a large commitment from the school board, possibly the Mayor or Governor, and others involved in city—or statewide decisionmaking. Each project uses the expertise of researchers from a variety of public health fields, as well as substantial public involvement. The staff time and the financial backing necessary to see the project to completion may not be available in many cases. Not only are resources difficult to obtain, but as this report has shown, often inadequate data exist on which to make decisions with anything nearing useful certainty. Risk ranking requires considerable information on the nature of the risk and its potential impact on the community.

MANAGING RISKS

Setting priorities for risk reduction is more than simply ranking risks. As many observers have remarked, to set priorities means to guide where *resources* should flow (9). The biggest problems may bear no resemblance to the highest priorities for risk reduction. Large risks may have no socially, politically, technologically, or economically acceptable means of control or prevention, while small risks may be eliminated through actions that carry a small or even a negative economic price tag. Therefore, even if none of the social dimensions of risk are to be included in the analyst's attempt at risk comparison, decisionmakers and stakeholders need information on the feasibility and costs of *specific interventions* in order to judge where resources should go. These estimates may be as uncertain as the risk estimates and may add further complexity to the social process, but the alternative is either to rank the risks alone and have no guide for policy, or (perhaps worse) for decisionmakers to assume that the risk ranking equals the resource allocation.

Any commitment to a risk-control policy is likely to be supported by a web of beliefs about the magnitude of the risk and the effectiveness of the policy (5). Some of these beliefs will be accurate, and others erroneous. Still others will be half-truths, correct beliefs that ignore parts of the problem—such as the other uses for the resources being spent.

People may also be confused, caught up in the chaotic process by which risks are nominated for consideration. Alarming stories in the media may psychologically commit them to certain safety measures, such as installing school metal detectors or removing asbestos, and they may find it difficult to abandon these strategies. They may feel unbearable pressure to deal with minor risks that the media and others shove into the center of their field of vision.

Regardless of the sizes of the risks or the strength of public perception, limited resources constrain the possible alternatives for risk reduction. The purpose of comparing a wide range of risks in schools is to help allocate or reallocate resources among the many possible risk reduction options, including the option of no action on a certain perceived risk. The result of the process may be to reduce the controls on some risk-producing activities and channel resources elsewhere, into other risk-reducing activities or even activities unrelated to risk reduction.

Some observers criticize these "zero-sum" choices, where governments and school boards declare they can address only one risk or another (12). In fact, parents will likely view funds spent on school safety as nonnegotiable, and they may

discount claims of fungibility: they will rarely accept a trade of more books for less safety. The public may accept funds being spent more efficiently, but not at a cost of visibly greater risks to students.

To such a combustible and emotional debate, the need for objective analyses, understandable information, and direct communication becomes increasingly clear. This report, then, consists of a first step in this process.

REFERENCES

1. Cleland-Hamnett, W., "The Role of Comparative Risk Analysis," *EPA Journal* (January/February/March):18–23, 1993.
2. Cohen, B., and Lee, I.S., "A Catalog of Risks," *Health Physics* 36:707–722, 1979.
3. Finkel, A., *Comparing Risks Thoughtfully* (Washington, DC: Resources for the Future, September 1994).
4. Finkel, A.M., and Golding, D. (eds.), *Worst Things First? The Debate over Risk-Based National Environmental Priorities* (Washington, DC: Resources for the Future, Johns Hopkins University Press, 1994).
5. Fischoff, B., *Ranking Risks* (Pittsburgh, PA: Carnegie Mellon University, Department of Social and Decision Sciences, February 1994).
6. Fischoff, B., "Acceptable Risk: A Conceptual Proposal," *Risk: Health, Safety, and Environment* 5(1):1–28, 1994a.
7. Glickman, T., and Gough, M. (eds.), *Readings in Risk* (Washington, DC: Resources for the Future, 1990).
8. Gregory, R., and Lichtenstein, S., "A Hint of Risk: Tradeoffs Between Quantitative and Qualitative Risk Factors," *Risk Analysis* 14:199–206, 1994.
9. Hattis, D., and Goble, R., "Current Priority-Setting Methodology: Too Little Rationality or Too Much?" *Worst Things First? The Debate over Risk-Based National Environmental Priorities,* A.M. Finkel and D. Golding (eds.) (Washington, DC: Resources for the Future, Johns Hopkins University Press, 1994).
10. Hornstein, D.T., "Reclaiming Environmental Law: A Normative Critique of Comparative Risk Analysis," *Columbia Journal of Environmental Law* 92:501–571, July 1992.
11. Minard, D., et al., "State Comparative Risk Projects: A Force for Change," *Comparative Risk Analysis,* hearing before the Subcommittee on Technology, Environment, and Aviation, Committee on Science, House of Representatives, U.S. Congress, February 3, 1994, Serial No. 103-91 (Washington, DC: U.S. Government Printing Office, 1994).
12. O'Brien, M.A., "Proposal to Address, Rather Than Rank, Environmental Problems," *Worst Things First? The Debate over Risk-Based National Environmental Priorities,* A.M. Finkel and D. Golding (eds.) (Washington, DC: Resources for the Future, Johns Hopkins University Press, 1994).
13. Roth, E., et al., "What Do We Know about Making Risk Comparisons?" *Risk Analysis* 10(3):375–388, 1990.
14. "Rothschild's Numerate Arrogance," *Nature* 276:429, 1978.
15. Shrader-Frechette, K., *Risk and Rationality: Philosophical Foundations for Populist Reform* (Berkeley, CA: University of California Press, 1991).
16. Stone, R., "California Report Sets Standard for Comparing Risks," *Science* 266:214, 1994.
17. Templet, P., Louisiana State University, Baton Rouge, LA, "Statement," *Comparative Risk Analysis,* hearing before the Subcommittee on Technology, Environment, and Aviation, Committee on Science, House of Representatives, U.S. Congress, February 3, 1994, Serial No. 103-91 (Washington, DC: U.S. Government Printing Office, 1994).
18. U.S. Environmental Protection Agency, Office of Policy Analysis, *Unfinished Business: A Comparative Assessment of Environmental Problems* (Washington, DC: 1987).

19. U.S. Environmental Protection Agency, Science Advisory Board, *Reducing Risk: Setting Priorities and Strategies for Environmental Protection*, SAB-EC-90-021 (Washington, DC: 1990).

20. Weitzman, M., "School Absence: A Problem for the Pediatrician," *Pediatrics* 69:739–746, 1982.