Issues in School Health and Safety 2

Schools, like all buildings and institutions, harbor some risks. Some of the illnesses and injuries in schools stem from preventable or reducible hazards. Nevertheless, compared to other places where children live and play, schools are often safer environments. This finding must be qualified by the paucity and occasional poor quality of data—or even the absence of information about some hazards.

Children daily confront a variety of risks, in or out of school. In 1992, children ages 5 to 17 suffered 13 million injuries and some 55 million respiratory infections, which contributed to their missing about 214 million school days, roughly 460 days for every 100 students. Unknown are the possible long-term health consequences, the impact of the lost learning opportunities, or the care-giving problems faced by families.

Averaged over the year, school-aged children spend about 12 percent of their time in school, and some portion of these injuries and illnesses arise in connection with the school environment. Since government requires school attendance, it ultimately bears responsibility for children's health and safety while they are there. While local, county, and state governments bear most responsibility for the operation of schools, the federal government has taken a role in health and safety issues, as reflected in the 103d Congress considering 66 bills that referenced the "school environment" and 51 that were directed at the goal of "safe schools." Congressional concern led the House Education and Labor and Energy and Commerce Committees of the 103d Congress to request this report, which examines the scientific data on the risks for injury and illness in the school environment.[1]

Important interactions between the student's home life—such as the presence of only a single parent, poor family dynamics, limited supervision, or poor nutrition—and school-connected behavior and health and safety problems are beyond the scope of this report, as are mental health problems of children and adolescents. "Behavioral" risks, such as drugs and pregnancies, are high on the public's list of concerns, but they are not included in this report. Two OTA reports, *Healthy Children: Investing in the Future* (25) and *Adolescent Health (*26), provide broader information about the health of children

[1] In the 104th Congress, the House Education and Labor Committee was renamed the Education and Opportunity Committee and the House Energy and Commerce Committee became the Commerce Committee.

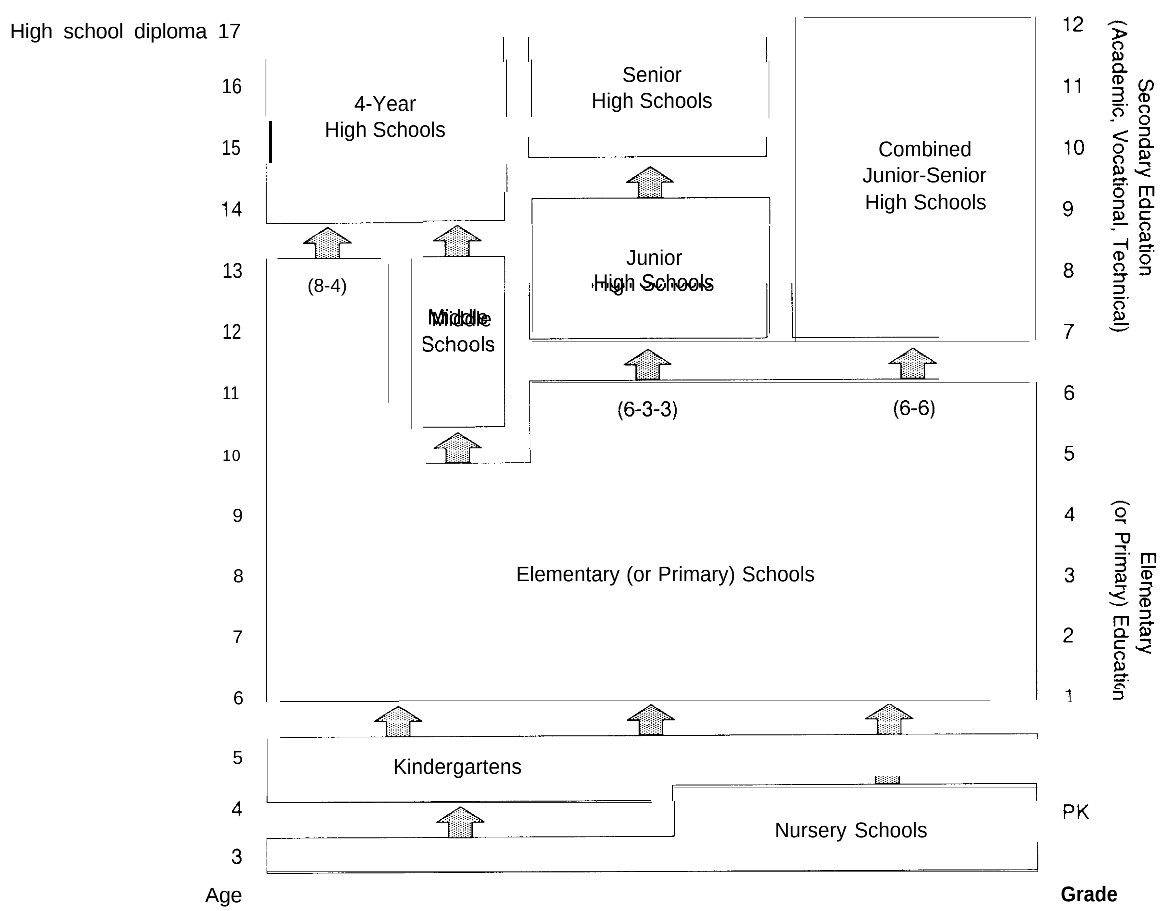
and adolescents through 18 years of age; this report is narrowly centered on health and safety risks to students while in school.

This chapter introduces the issues of school health and safety. It initially describes the student population and the school environment. The rest of the chapter is devoted to introducing concepts concerning health and safety data: the nature of the studies generating them, how the data are collected and interpreted, and the inherent difficulties in obtaining reliable and credible information. It ends by discussing the significance of risk estimates in deciding which risks need to be reduced, strategies for reducing them, and to what levels they should be reduced.

Student Population

The student population covered in this report spans the ages 5 to 18, which correspond to grades kindergarten through the 12th grade (see figure 2-l). According to census figures (31), over 46 million children were enrolled in the 109,000 elementary (kindergarten-8th grades) and secondary (9th–12th grades) schools for the 1990 school year, and a projected 50 million will enroll for the fall of 1995 (see table 2-1A and 1B). Except for the section on lead, the report does not cover nursery schools and students below the age of 5, nor does it cover the provision of health care in schools.

FIGURE 2-1: The Structure of Education in the United States



SOURCE: U.S. Department of Education, National Center for Education Statistics

TABLE 2-1A: Enrollment in Educational Institutions by Level and Control of Institution: Fall 1990 to Fall 1995 (in thousands)

Level of Instruction and Type of Control	Fall 1990	Projected Fall 1995
Elementary and secondary education[a]	46,448	50,709
Public	41,217	45,049
Private	5,232	5,660
Grades K-8[b]	33,973	36,668
Public	29,878	32,275
Private	4,095	4,393
Grades 9-12	12,475	14,041
Public	11,338	12,774
Private	1,137	1,267

[a] Includes enrollments in local public school systems and in most private schools (religiously affiliated and nonsectarian). Excludes subcollegiate departments of institutions of higher education, residential schools for exceptional children, and federal schools. Excludes preprimary pupils in schools that do not offer first grade or above.
[b] Includes kindergarten and some nursery school pupils.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Common Core of Data and “Fall Enrollment in Institutions of Higher Education” surveys; Integrated Postsecondary Education Data System (IPEDS), “Fall Enrollment” surveys; and *Projections of Education Statistics to 2004*.

TABLE 2-1B: Public School Districts and Public and Private Elementary and Secondary Schools: 1990-91

School Year	1990-1991
Public school district	15,358
Public Schools	
Total all schools	84,538
Total all regular schools	81,746
Elementary Schools	
Total	61,340
One-teacher	617
Secondary Schools	22,731
Private Schools	
Total	24,690
Elementary	22,223
Secondary	8,989

SOURCES: U.S. Department of Education, National Center for Education Statistics, Statistics of State School Systems; Statistics of Public Elementary and Secondary School Systems; Statistics of Nonpublic Elementary and Secondary Schools; Private Schools in American Education; and Common Core of Data surveys.

Almost all information concerning school-based risks comes from studies and reports related to public schools. While the data could be applied to the 5 million children in the 24,690 private schools, this report could not find data suggesting one way or the other the appropriateness of that application.

One admitted data shortfall is limited knowledge about the particular susceptibilities of school-aged children, as age is known to be a major determinant of individual risks for particular illnesses and injuries (1,21). In general, compared to adults, children absorb more of any substance in the environment because of the larger ratios of their skin surface and, lung surface area to body weight and their higher metabolic rates. Because of the ongoing growth processes in children, many injuries, for example to the head, can have long-term health implications. These differences have implications for the interpretation of data on school children since most health studies are conducted on adults, and children may not be adequately addressed in the design or analysis of the data.

School Environment

Schools’ primary mission is education; their end product can be considered an educated individual. Given the importance of education for an individual’s ultimate happiness and satisfaction and the documented benefits to society of an education (34), disruption of the learning process must be considered an adverse effect. Clearly a sick or injured student, even if he or she attends school, is not as prepared to learn as a well student. A student fearful about assault or other violence on the way to and from school or on the playground is not prepared to learn.

Although the impact of sickness or injury on learning is difficult to estimate, one measure of this impact—used in this report—is the number of school days lost from an injury or illness. Injuries and illnesses resulting in absences from school may impede the learning process: a committee of pediatricians reviewed the medical and educational literature and concluded that "children that are frequently or persistently absent from school tend to perform poorly in school and are likely to drop out before graduation" *(*34). Further, they cited a number of social implications, including maladaptive behavior and future unemployment and welfare costs, as ramifications of excessive school absence.

School absences stem from many sources, and injuries and illnesses from the school environment make some unknown contribution to them. Even though the contribution of the school environment to a student's health and education has been discussed for decades *(*6,12,23), our understanding of it remains limited. Complicating our understanding is the lack of knowledge of the environmental, structural, and social hazards found in schools *(*22), which is partly manifested in not knowing which injuries and illnesses originate in schools and which arise elsewhere.

Despite the lack of knowledge of the hazards in them, schools contribute to student safety by protecting them from most hazards and instructing them on how to live safely in an often dangerous world. School prevents exposures to many of the worst risks. A student sitting at a desk, changing classes in an orderly fashion, and playing in supervised sports is likely to be safer than a child in unsupervised play in a neighborhood playground or park. As discussed in Chapter 1, relatively few deaths (less than 1 percent) occur in schools or school buses from the two leading causes of death in school-aged children, motor vehicles and firearms.

Schools also teach the proper use of potentially hazardous equipment, safe conduct on playgrounds and in athletic activities (like swimming), and respect for others and for dangerous situations. These skills carry over to the nonschool environment since many of the same activities occur off the school grounds. In addition, a growing number of organizations offer school-based programs that teach children the importance of health, safety, and the environment. One of the most notable examples is the Enviro-Cops program in the Dade County school system (see box 2-1). Because of this instruction and because of constant supervision by responsible adults, schools are often a safer place for children than most nonschool environments. Despite the concern for school safety, especially school violence, the overwhelming majority of polled school board members responded that they believed schools are still safe places for students and staff *(*33).

HEALTH AND SAFETY DATA

Collecting and analyzing data about illnesses and injuries are the cornerstones of efforts to identify and control health and safety risks. Although data and estimations come from different sources and are collected by different processes, certain generalities describe the data for the four kinds of risks that are considered here: unintentional injury, intentional injury, environmental illness, and infectious disease. The sources of data are considered in detail in the appropriate section; the following briefly discusses the nature of the data collection and interpretation.

■ Nature of Data Collection

Data collection constitutes the first, and in many ways, the most important step in having credible, usable, and understandable information for making decisions. The kinds of data described in this report are usually derived from *surveys* or *reporting systems* that specify what sorts of data to collect. More specific data and, generally, more information important to the interpretation of the data are collected through focused studies.

Despite the obvious desirability of more complete information on the hazards facing children in schools, obstacles to data collection activities exist. Obstacles can be simple, such as the lack of resources—money, expertise, or both—or more complicated, like the fear of being branded a "problem school."

Surveillance: Surveys and Reporting Systems

Surveillance is an active process for collecting, analyzing, and disseminating information on the occurrence of illness or injury *(*4). The meth-

BOX 2-1: Enviro-Cops and Enviro-Mentors

Enviro-Cops/Enviro-Mentors is just one of many successful programs concentrating on making the world safe for children. The Enviro-Cops and Enviro-Mentors program involves students in projects that teach them to save energy, recycle, and eat well, as well as personal, home, auto, and bicycle safety. The Enviro-Cops program starts with second grade students of the Dade County public school system. It teaches them to be eco-smart while developing their self-esteem and personal safety. More than 225,000 elementary school students have become involved with Enviro-Cops. Many of the Enviro-Cops continue their involvement in the program and return to become Enviro-Mentors, which is the second half of the program and consists of high school and college students who volunteer to be role models for the younger students.

Enviro-Cops take on many issues that affect all of the children of the world. The program incorporates safety issues, including personal safety (for example, eating good food, avoiding guns ("see a gun, dial 911"), and saying no to drugs and alcohol), traffic safety (such as wearing bicycle helmets and seat belts and using child seats for younger children), and environmental safety (like confronting issues such as the use of pesticides, the depletion of the world's resources, and destruction of the world). Enviro-Cops actively help reduce waste, recycle, precycle, and reuse. They learn that their actions do make a difference and that they can make the world safe for themselves, their families, their friends, and everyone else.

SOURCE: ARISE Foundation, *Enviro-Cops Guidebook and Lesson Plans*, 1993. ARISE Foundation, *A 10-Year Retrospective*, 1993.

odology for surveillance activities is basically descriptive. Its functions, however, extend beyond data gathering, as the information forms the basis for action by authorities to control or prevent public health hazards.

Surveillance systems were first developed for illnesses from infectious diseases and more recently are becoming established for other causes of disease and injury. Although disease surveillance began in the mid-1800s in England and Wales, in this country the collection of national morbidity data began in 1878, when Congress authorized the Public Health Service to collect reports of the occurrence of quarantined diseases such as cholera, smallpox, plague, and yellow fever (4). In 1893, Congress passed an act stating that weekly health information should be collected from all state and municipal authorities. This developed over time into a weekly bulletin: the *Morbidity and Mortality Weekly Report* (MMWR), issued by the Centers for Disease Control and Prevention (CDC), which was given responsibility for receiving morbidity reports from states and cities in 1960. National disease surveillance programs are maintained by most countries, and the World Health Organization (WHO) maintains a global surveillance system on quarantined and other selected diseases (2).

In establishing its global surveillance system, the WHO (35) identified 10 distinct sources of surveillance information. Sources of surveillance data relevant to this report include mortality and morbidity data, individual case reports for rare diseases or unusual cases, and the reports of epidemics for clusters of cases. Surveys, such as household or population surveys, can provide information on the prevalence and occurrence of a disease. Demographic information, such as age, and environmental information, such as the presence of lead, are also important sources of data.

Surveillance systems are run from central locations with the objective of monitoring a region—local or national—for any changes in the incidence or nature of particular injuries or illnesses. Surveillance data are often reported by health providers to health authorities, such as the state health department. Reporting can be routine or active for specific cases, but both cases require a standardized process whereby comparisons can be made between and across geography or time.

Data collection forms are distributed to the reporting units, and the completed forms are usually collected with similar forms, sometimes analyzed, and sometimes simply stored away.

Some well-established systems, such as the CDC's MMWR, are designed to disseminate the collected information. Other reporting systems may not disseminate the information as widely because the system may be designed for purely local purposes, or because of other reasons, such as fear of bad publicity. For example, school nurses file reports for observed injuries and illnesses, but these reports are often not released to the public. In any case, regardless of the difficulties of establishing and maintaining a survey or reporting system, these activities must be compatible with other sets of data. Surveys and studies must follow accepted or clearly described protocols if the results are to be informative and useful.

Studies

In contrast to the standardization and routine of surveys or reporting systems, studies can be designed to investigate a particular outbreak or situation, and thus require careful attention to design, execution, and analysis. Studies can be especially informative because they allow researchers to account for the complexity of the school environment and activities by incorporating relevant information from the community, such as lead being released from a nearby smelter. That flexibility also increases the complexity of the study. Epidemiological studies provide most of the relevant data in this report. However, toxicological and human exposure studies also provide important information for determining students' risks.

Epidemiological studies

Epidemiology is the study of the distribution of disease in human populations and the factors that influence the distribution of disease. Epidemiological techniques are used to identify causes of disease and determine associations between disease and risks. There are three basic designs for such studies: descriptive, experimental, and observational. This section provides a simple sketch of the field and defines some terms for the reader with no background in epidemiology. For more in-depth discussions, there are many available references, including Hennekens and Buring (13), Lilienfeld (18), Evans (8), and Brachman (4).

Descriptive epidemiology studies examine the patterns of distribution of disease and the extent of disease in populations in relation to characteristics such as age, gender, race, etc. Sources for descriptive studies include census data, vital statistics data, and clinical records from hospitals and private practices. By examining the differences in disease rates over time, descriptive epidemiology provides clues about disease causation. Descriptive studies can also focus on comparisons of geographical regions.

Experimental epidemiology studies involve a deliberate exposure or withholding of a factor and observing any effect that might appear. In these studies the investigator controls exposure to a risk and assigns subjects, usually at random, to either receive the treatment/risk or a placebo. The effects on the two groups are compared and analyzed. Experimental studies are hard to conduct, however, because of the need for a cooperative and eligible group of individuals who will allow intervention in their lives. Also, ethical reasons (either withholding a beneficial treatment from some subjects or introducing subjects to potentially harmful treatments) may make the study difficult to conduct.

Observational epidemiology studies analyze data from observations of individuals or relatively small groups of people in order to determine whether or not a statistical association exists between a factor and disease. Observational studies have two design options: cohort studies or case-control studies. In either design, the risk factor under investigation should define the groups, which otherwise should be comparable.

Cohort studies look forward (prospective), choosing subjects who are free from the disease under study, but who differ in respect to the risk factor under study. The health status of the individuals in the study group is observed over time to determine whether there is an increased risk of a disease associated with that exposure.

Case-control studies, on the other hand, compare individuals with the disease under study (cases) with individuals who do not have the disease under study (controls). Risk factors that are thought to be relevant to the study are compared between the groups. The extent of exposure to the risk in the case group is contrasted with the extent of exposure in the control group. Because of the presence or absence of the risk factor in the past, case-control studies are retrospective studies.

Toxicological Studies

Most often, the information needed to predict adverse health outcomes from exposure to potentially hazardous chemicals comes from testing substances in animals or through *in vitro* tests, that is, in cells or tissues isolated from animals and humans. Such toxicological studies allow scientists to test chemicals and control conditions that cannot be controlled in most epidemiological studies, such as the amount and conditions of exposure and the genetic variability of the subjects. Toxicological studies are the only means available to evaluate the risks of new chemicals.

Biologically, animals, even the rats and mice typically used in toxicity testing, resemble humans in many ways. A substantial body of evidence indicates that results from animal studies can be used to infer hazards to human health (14,15,16). There are exceptions to this generalization, but each must be proved to be able to set aside the assumption that animal tests are predictive.

Toxicological disciplines can be distinguished by the "endpoint" studied, the resulting disease or the organ affected by exposure to a toxic substance. Increasingly, researchers are studying subtle endpoints other than cancer, such as immunotoxicity (27), neurotoxicity (29), reproductive and developmental toxicity, liver and kidney toxicity, and lung toxicity (28). More attention is also being devoted to studying the effects of long-term (chronic) exposures, rather than the effects of large, short-term (acute) exposures.[2]

Toxicological studies, however, have limitations. Cost considerations limit most animal studies to a few hundred test animals, and in most instances, researchers use high levels of exposure to increase the likelihood of observing a statistically significant effect in a relatively small group of animals. It can also be very difficult to verify any quantitative extrapolation of the results of animal studies to human effects. The reader is directed to the many detailed references in toxicology, in particular Klaassen et al. (17).

Human Exposure Studies

Human exposure studies measure the presence of an agent in air, soil, or food. The most accurate information about exposure is based on monitoring the amounts of a substance to which people are exposed (20). Personal monitoring measures the actual concentrations of a hazardous substance to which people are exposed by using devices that individuals wear or by sampling the food, air, and water they eat, breathe, and drink. Biological monitoring measures the toxicant or its metabolite in biological samples such as blood or urine. Ambient monitoring measures hazardous substances in air, water, or soil at fixed locations. That method is often used to provide information about the exposure of large populations, such as people exposed to air pollution in a region. Often, monitoring data are not available. As a result, assessors often estimate exposures to emissions from a distant source like a factory by using exposure models (20). Exposure models simulate the dispersion of substances in the environment.

[2] For excellent reviews and research papers on the various types of toxicological studies on noncancer effects being conducted, see Environmental Health Perspectives, 1993, vol. 100; in particular see Luster and Rosenthal (19); Schwetz and Harris (24); and Fowler (10).

Difficulties with Data Interpretation

Data, however collected, are usually analyzed for their implications and significance at the local level. These analyses use the results of an investigation—"raw data"—and place it in context of the reliability and the strengths, weaknesses, and limitations of the methods used. Analysts and decisionmakers are best able to do their work when they understand the process of measuring adverse events and the numerical estimates of risk; the nature of the data; and the problems inherent in their interpretation. This is particularly true when the data are being used to support legislation or public health action because of the likely scrutiny and the resulting commitments of resources. Besides estimating the likelihood of injuries and illnesses, analysts and decisionmakers must consider the quality, relevance, and predictive value of the available data.

Data are always limited, and generalizations and extrapolations are often necessary to interpret and apply the available data. Most often, gaps in data, knowledge, or both force the use of assumptions and generalizations in drawing conclusions. Even with sufficient data, however, interpretation can be fraught with difficulties. This section describes some of these difficulties in data interpretation.

Completeness and Generalizability of Data

For some hazards, the only information comes from limited studies of specific populations. It is common practice to generalize results from studies of one or a few schools to schools statewide or even nationally. Two types of generalizations are commonly made: *geographic* generalizations use data from one area, such as urban schools, and generalize to another setting, such as suburban schools. Conversely, national databases can be used to infer risks to certain schools or student subpopulations. Similarly, *temporal* generalizations apply results from earlier studies to current circumstances.

All data-reporting systems confront problems of underreporting, self-reporting, and selection bias. School injury data, for example, rely almost entirely on school-based reporting, for which the common methodological concern is underreporting (11). One study designed to measure the extent of underreporting found that for every injury reported, about 4.3 injuries go unreported; however, most of the injuries that are not reported are minor (9). Reporting practices may also vary from school to school. These discrepancies can result in an injury problem being overlooked at a school or the employment of inappropriate remediation measures.

Most of what is known about the risk of intentional injury in schools is derived from voluntary, school-based surveys of particular behaviors, such as physical fighting and willingness to carry a weapon, or particular injuries or illnesses. Frequently, however, response rates are poor, and students do not report honestly. Administrators and school officials from major districts do not always respond to national surveys.

Health questionnaires are often given to patients or family members who must rely on their memory of the illness to describe symptoms. Such self-reporting involves subjective and selective recall about exposures and health effects (18). The National Health Interview Survey relies on parental recall of their children's illnesses. To overcome the problems of faulty recall, they return to the family every other week (3). This requires the careful analyst to look for additional evidence or supporting examples before drawing conclusions.

Even accounting for underreporting and self-reporting, analysts of injury and illness data must determine the extent to which the study can be representative of the larger population or only a narrow segment of it. Even well-designed studies can fall victim to what is termed "selection" bias, where an association is thought to exist but is in reality an artifact of the population being studied. In the case of schools, the finding of illness in certain schools may reflect underlying difficulties of a particular school or small group of schools—not schools at large. For example, a survey of schools with indoor air quality problems is not representative of air quality in schools generally but represents "problem schools," which suffer from actual or perceived elevated indoor air contaminants or other indoor air quality problems.

Uncertainty and Variability

Estimates of the health risks are both uncertain and variable. *Uncertainty* means that we do not yet know the true risk; uncertainty can be reduced through additional data or research. For example, uncertainty exists in estimates of injuries on school playgrounds because of underreporting. *Variability*, in contrast, means that the risk differs considerably from school to school or person to person; variability cannot be reduced, only better understood. Variability appears in estimates of the likelihood that any single smoker will develop lung cancer: some do, and some do not, based on a variety of individual factors that include age and genetics but may include other factors that are not now recognized.

Extrapolation

Extrapolation is most often seen as a problem in environmental health studies. The use of animal data requires extrapolating from animal results to human projections, and from very high exposures to low exposures. When human data are available, they are usually from studies of high levels of exposure, mostly in occupational settings. Analysts then have to extrapolate from the effects of high-level exposures to mostly healthy, working-age men in order to predict effects in young people of varying health characteristics in the school environment. The most prominent occupational-to-school risk extrapolations found in this study are those for lung cancers arising from asbestos or radon exposures. The data come from high-level occupational exposures of populations of men that included many smokers.

Extrapolations are not limited to the environmental health arena. For example, there are no school transportation injury data; thus, injury data reported for school-aged school bus occupants, pedestrians, and bicyclists are assumed to represent students on their way to and from school.

MOTIVATIONS FOR DATA COLLECTION AND ANALYSIS

A fundamental problem for everyone concerned about risks in schools is whether the available information is good enough to help make the decision to accept a risk or expend resources trying to reduce it. It is impossible to collect all the data that might be useful. Instead, analysis of the available data and careful thought about what kinds of data might alter an already-made or pending decision can guide the decision on what additional data to collect.

The surveys and studies that generate health and safety data are usually quite expensive and time-consuming and require considerable expertise to conduct. Decisions to expend those resources can be made for one or more specific reasons, and knowledge of the reasons can help in understanding how the surveys and studies were designed and by whom and the principle objectives of the research. These reasons can include legal requirements (e.g., federal, state, or local reporting laws), litigation, investigations of "rashes" or "outbreaks" of injuries or illnesses, or fear of adverse health effects. These motivations sometimes impugn the credibility of researchers, reducing the usefulness of their results.

Mandates

The most potent motivations for collecting health and safety data are laws that mandate reporting of various kinds. Illnesses and the potential for exposures to environmental toxics are subject to more mandated reporting requirements in schools than are injuries. On the federal level, the Federal Bureau of Investigation (FBI) requires reporting of homicides and suicides, but not in such a way that permits identification of those that occur in schools. Three agencies collect intentional school injury data for national surveys, but there are no mandated nationally reporting systems.

Some federal laws require either the reporting of illnesses and the potential for exposures or the identification of hazards. The Asbestos School

Hazard Abatement Act of 1985 and its 1990 reauthorization (ASHAA) require schools to inspect for asbestos. Both the Superfund Amendments and Reauthorization Act of 1986 and the Indoor Radon Abatement Act of 1988 directed the U.S. Environmental Protection Agency (EPA) to conduct surveys of radon concentrations in schools (as well as other buildings), and the school survey results were reported to Congress in 1993 (32). School are encouraged but not required, under the 1988 Lead Contamination Control Act, to test their drinking water and meet a recommended lead level.

Some states also have reporting requirements. Three—Hawaii, South Carolina, and Utah—have voluntary school injury reporting. Some states require reporting of school crimes, including those involving intentional injuries; the South Carolina legislature was the first to pass such legislation. Other state laws and initiatives trigger investigations or surveillance of environmental illness. California and Washington require the reporting of pesticide illness, including school exposures. South Carolina requires lead testing in day care facilities and foster homes as a condition of licensure. The New York City board of education monitors the physical appearance of all school buildings on an ongoing basis and presents its findings about such hazards as lead paint chips on an annual basis.

Fear and Litigation

Fear and concern can also motivate data collection, resulting in an ebb and flow over time. Urban violence has resulted in increased interest in weapons carrying, not only in big cities but in smaller communities as well. If concern about that wanes, fewer studies of weapons carrying can be expected. The installation of resilient pads covering the ground of some New York City playgrounds dramatically decreased injuries from falls, reducing the motivation for continued surveillance of such injuries. To a major extent, public perceptions of risk provide the motivation for data collection and studies, and that motivation is transmitted through legislation, legal actions, and public pressure.

Data collections and investigations are also performed in anticipation of possible litigation and as a response to pending litigation. Litigation against schools is increasing, particularly negligence cases (11). As a defensive measure, some schools attempt to keep records of injuries occurring on school grounds. However, unless there is an actual suit, these records are rarely tallied and analyzed, and thus are of no value in estimating injury risks. Lawsuits against schools for environmental exposures have led to the gathering of exposure data. A lawsuit filed against the state of Texas required various investigators to assess the presence and concentration of asbestos in the state schools (7). A lawsuit by a teachers' union forced California to investigate EMF exposures (5). Because large sums of money are often involved in litigation, researchers can obtain research funds to conduct studies they otherwise could not afford. However, they must maintain strict independence and follow scientific protocols to avoid perceptions of biased research, which damage the credibility of the results.

Credibility of Researchers, Bias, and Fraud

Researchers and investigators who collect health and safety data and conduct studies about risks can come to their tasks with or without vested interests. People who depend on those data and who disagree with them can accuse the researchers of bias or fraud, even if there is little evidence for the charges. The media can report those charges, giving them credibility, without any independent investigation.

Consider the situation when stakeholders in arguments about risk generate some of the data necessary for decisionmaking. They are tarred with bias no matter how honestly they do their work. On one side of the ideological spectrum, investigators may believe a particular agent or environment, such as a school setting, is responsible for adverse health effects and gather data to show an association between exposure and effect, with the objective of forcing government action or winning a lawsuit. On the other side, studies conducted or supported by manufacturers of a substance under suspicion or those responsible for releasing it into the environment, or by a school district that wants to avoid paying for risk removal, may be viewed skeptically, especially if they fail to show an association between exposure and illness.

Bias or prejudice can be knowing or unknowing, overt or covert, and it can be readily apparent or hidden from all but the most astute observer. Moreover, neither bias nor prejudice may play a role in data collection or study, but either one can be cited as a criticism by participants in a controversy who do not agree with the study results. The conventions of both science, which include publication of results and making data available to other researchers, and democracy, which include discussion, public accountability, and involvement of concerned parties, will not necessarily erase unwarranted charges or validate accurate ones. Nevertheless, they are the most effective tools for ensuring that data are as accurate as possible, that the methods used to collect the data are appropriate, and that the presentation of results is as free from bias as possible.

THE SIGNIFICANCE OF RISKS AND ESTIMATES

This study is intended to inform decisionmakers about the available information and its sources, and to provide some evaluation of the quality of that information. Deciding what to do, if anything, about any of these risks involves consideration of many more factors than are covered here—including fairness, public fears, cost, and feasibility of controlling the risk.

The results of available risk estimates can be compared against certain thresholds or standards as indicators of their significance. In discussions with experts and administrators who contributed data and information to this report, four general kinds of comparisons emerged: baselines, endpoints, school vs. nonschool risks, and risk thresholds.

Baselines

Baseline values are the normal background rates of the injuries or illnesses against which the risk from a particular hazard can be compared. Whether in comparing different risks or evaluating various policy options, baseline values are used as the expected numbers of illnesses and injuries. Officials use baselines to identify hazards by recording increased incidence or monitoring certain trends to see whether the measured rates are above or below the levels expected in a population. There are few established baselines, but the ones that exist are widely applied. Increases in influenza are identified by comparing current reported cases to historical averages; the District of Columbia's 11 percent decrease in homicides in 1994 is based on a comparison of the numbers of killings in 1992 and 1993.

A number of states have established or are attempting to establish a database to track trends in school injuries. More subtle baselines have been established as well. The CDC's Youth Risk Behavior System is creating baselines for behaviors that can forecast risks of intentional injuries in school.

Endpoints

This report uses the incidence of death, injury, or illness as a measure of risk. However, incidence only refers to the number and frequency and not the severity of risk, which—to a large extent—determines the risk's health impact. The impact of risks can be evaluated by considering their endpoints, as measured by the nature of the injury or illness. Endpoints can range from acute effects such as poisonings and broken bones to chronic effects including cancer and debilitating injuries that result in paralysis. Some endpoints—traumatic death, death from cancer, long-term mental or physical impairment—are far worse than others—a scrape or bruise, a 24-hour fever. Beyond such obvious differences, it is difficult to put endpoints on a comparative scale. The endpoints, or impacts, of illnesses and injuries can be distinctly different from each other, and the differences complicate comparisons of risks.

Even with related endpoints, comparisons remain complicated. Most significantly, methods for determining risks of the major risk factors differ: infectious diseases and injuries are counted and measured; illnesses from environmental hazards are estimated for some and counted for others. One endpoint used in this report common to both injury or illness is measuring the number of school days lost.

School and Nonschool Risks

Children and adolescents spend some time in school and a much greater proportion of their time elsewhere. One way to put school risks in perspective is to compare them to nonschool risks. This report, wherever possible, compared injuries and illnesses in school, where students spend about 12 percent of their total time, to injuries and illnesses in the nonschool environment, making allowances for the different times spent in the two environments.

In this report, safety is described in terms of relative risk between in-school and out-of-school. Such comparisons to other environments where children spend time may show that schools and school grounds offer a "safer" environment from certain risks, i.e., relative to out-of-school environments, in-school exposures to a potentially harmful situation for injury or illness may not be as great; conversely, in other situations, the risk is greater and hazards may be more prevalent in schools. Safety is a relative term since it is not a guarantee of a risk-free environment—violence even erupts in "safe cities" and on "safe streets" and in peaceful rural areas. Infections are spread in clean homes and schools and in hospitals despite expert, directed precautions. Nevertheless, comparisons serve to illuminate differences inherent in the various environments in which children learn, play, and reside.

Risk Thresholds for Intervention

Wherever possible, OTA presents baselines or nonschool comparisons and, in a few cases, regulatory exposure limits, all of which can serve as benchmarks to help determine whether interventions are warranted. This information comes from a variety of sources, including federal or state governments and other credible authorities. School-specific benchmarks are most useful, but few are available. More general comparisons, from nonschool situations, are best used with care, but they provide important information for decisionmaking. Federal, state, and local regulations for many environmental hazards specify certain thresholds that trigger actions to reduce or prevent exposure.

Few regulatory thresholds exist for infectious disease or injury hazards. The tolerable level for injuries varies by type of injury and from community to community. Certainly, some levels are unacceptable. They are, equally, undefined. Some injuries are of high incidence and low severity, others are of low incidence and high severity, and reactions to them often differ. For example, proper playground surfacing may not be installed until a large number of children suffer abrasions or broken fingers, but one homicide can trigger installation of metal detectors.

A large number of cases of common childhood diseases may not elicit medical attention, but outbreaks of illness from foodborne pathogens or with high severity, such as meningitis, can trigger further investigation and interventions to prevent disease spread. There are, however, no specified thresholds that require action. Also, reported environmental illnesses—such as complaints about indoor air quality problems—can trigger investigations. In this case, no threshold has to be crossed; a complaint is sufficient.

Asbestos is an example where the presence of a substance, without knowledge of its concentrations, is sufficient to trigger some forms of intervention. EPA, as mandated by Congress, requires visual inspections of schools for the presence of asbestos-containing materials. Airborne asbestos fibers are the hazard in schools, but EPA never established a level of airborne asbestos that was considered sufficiently high to require action or sufficiently low to ignore.

In other cases, numerical thresholds exist. EPA can require remediation actions when lead concentrations in drinking water exceed 20 parts per billion. EPA does not enforce a standard for radon in homes, schools, or other buildings.[3]

ROAD MAP TO THIS REPORT

The remainder of this report presents the data on hazards in the school environment that can adversely affect students' health and a chapter on how these data may be used. OTA separates the hazards based on their health effects, whether injuries or illnesses. Chapter 3 covers injuries to students in schools and the nature, incidence, and causes of injuries. Injury is broken down by intentional and unintentional injuries. Unintentional injuries are injuries from playgrounds, school athletics, and transportation to and from school. Intentional injuries include homicides, suicides, physical fighting, and assaults.

Chapter 4 examines student illnesses. The major school-related causes of illness identified in the report are environmental hazards and infectious diseases. Environmental hazards include toxic materials in the school environment, indoor air quality problems, and hazards arising from the location of the school. Infectious diseases arise from a number of pathogenic organisms and either occur with a high incidence on an endemic or seasonal basis, or they occur less frequently and primarily as outbreaks.

The final chapter discusses how the data presented in the report can be used by decisionmakers—from Congress to individual school boards—in setting priorities for improving school safety. A section of the chapter examines other attributes of risks, beyond the numbers of deaths, injuries, or illnesses, that can play an important role in decisionmaking. A final section explores comparative risk assessment, a process that can be used for comparing and ranking the diverse risks in the school environment.

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[3] EPA has proposed a standard for radon in water (30), but recommends that homeowners undertake mitigation efforts when the radon concentration is equal to or exceeds 4 pCi/L; its report of the survey of radon in schools (23) emphasized that concentration as a level of concern.

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