Chapter 2

Ecology and public health- the science base.

public health is in essence ecological because health is determined in a multi- level environment that comprises all the physical, biological, social, cultural, behav- ioral, and spiritual forces that affect our development throughout our lives. All living organisms alter their environment to some extent by the mere fact of existing, but the interaction of humans and the environment is uniquely marked by the mag- nitude of the effect of the organism on the environment. The changes that people have produced are truly massive, with far reaching results on the nature of plant and animal life, the shape of physical features, and changes in climate.

In a broad sense, the structure of human society is determined by our biological characteristics and is modified by the immediate physical environment. However, the boundaries between the biological, social, and physical influences on human health and development are not clearly demarcated, and the three are in many ways overlapping and interdependent.

Biological Environment

The biological environment consists of the plants and animals with which we share our world. It serves as a source of food, shelter, implements, fiber, drugs, disease agents, and nonhuman companionship. It is not quite right to say that we depend upon the biological world for our survival, with the implication that we stand apart from the biological environment and draw our sustenance from it. Rather our dependence is more like the dependence of a child on the family; but the child is also a part of the family, with innate capabilities that are the result of the endowment received from the family. From the moment of conception, the child’s characteristics are modulated by the characteristics of the family. Likewise, human beings are a product of the biologi- cal environment; humans alter it, and are altered by it and remain a part of it.

Numerous noxious agents arise from the biological environment, including toxins and allergens from plant pollens, spores, organic house dust, feathers, moulds, and dander (dandruff ) from the skin of animals, that can provoke severe allergic respira- tory and dermatological disorders. Some of this is seasonal (e.g., hay fever), but other conditions can occur year-round. Plant juices from poison ivy and sumac can result in vesicular dermatitis while foods such as strawberries and seafood can cause allergic reactions ranging from mild urticaria to anaphylactic shock. Highly toxic substances can occur in potentially lethal amounts in nature: certain wild mushrooms are ined- ible, raw manioc root or cassava must be cooked to destroy the cyanide they con- tain, apricot kernels also contain cyanide and must be avoided as a food source, and bivalve mollusks can accumulate high levels of toxins produced by microscopic algae (dinoflagellates) when in bloom, which is why there is a regulated shellfish season in many parts of the world. Some plants may be therapeutic in certain dosages but toxic in overdoses such as cinchona tree bark (quinine) or foxglove leaves (digitalis). Others can be addictive, toxic, and therapeutic, such as the Oriental poppy (opium and its derivatives).

Reflecting their view of the biological world, ecologists have developed the con- cept of the ecological pyramid (Figure 2-1). This pyramid represents the flow of energy through the food chain, thus illustrating relationships between organisms in a particular ecosystem.

The base of the pyramid comprises organisms capable of synthesizing complex organic substances (e.g., carbohydrates) from simple inorganic materials by using light as an energy source (photosynthesis) or through chemical energy (chemos- ynthesis). These organisms are eaten by others, who are thus spared the necessity of starting at such an elemental level, and they in turn serve the nutritional needs of higher-order predators: this is also known as the “food chain.” There is a rough cor- relation between increasing size, decreasing numbers, and higher-order predation. Also, as the food chain pyramid is ascended, there is a significant decrease in the efficiency of energy transfer.

Since the primary food synthesizers form the foundation of the pyramid, it fol- lows that the nature of soil and vegetation in an area determines the nature of the animal life that depends on it for food. The nature of the vegetation depends sub- stantially on three factors: the physical features of the area, humans inhabiting the area, and chance. Humans have exerted a profound influence on vegetation through agricultural activities and through the transport of plant species into areas where they previously did not exist.

Physical features such as topography, climate, rainfall, and the texture and chemi- cal composition of the soil play a role in establishing terrestrial plant life. Similarly, the distribution and variety of marine vegetation are affected by analogous factors. Control is exercised by selection of species that are capable of existing best under a particular combination of these factors; the less fit are starved or crowded into a more specialized ecological niche or otherwise face extinction. The parallels between the influences exerted through these processes reveal that it is difficult to separate the physical and biological environment.

Human beings are an important contributor to the landscape. Our behavior operates through a number of ways, including use of fire and tools to clear land, selection of specific plants to nurture, importation of foreign species, breeding and cross-breeding livestock to develop more economically desirable forms, establish- ing water supplies independent of local climate, and changing soil characteristics in dramatic ways.

Ultimately, chance plays a role in many places, for instance, where certain types of plants are introduced inadvertently by animals, migratory birds, variations in currents of wind or water, or transported on people’s clothing or shoes. Another manner by which chance changes are introduced is through mutation, which may be predictable in the aggregate, but specific mutations that allow one version to subsist a little more successfully and thus replace less adaptable forms cannot always be foreseen.

These, then, are the basic determinants of that part of the environment that is mostly green and waves in sea currents or in the breeze.

Animal life is influenced by the same set of factors, although the emphasis is placed a little differently. This is a very important additional factor of the nature of vegetation: vegetation affects plant eaters, and plant eaters in turn affect animal eat- ers, and so on through the entire ecological pyramid, thus reflecting a complex array of relationships from symbiosis to parasitism. The improved reproductive advantage of organisms with favorable traits is referred to generally as natural selection, the process that lies at the core of evolution.

Human beings emerged in an environment that was presumably optimal for our species, or at least highly satisfactory. There are fierce arguments about whether or not parallel evolution of different strains of hominids proceeded in different places. However this may be, as the number of people increased or people fol- lowed game for food, there was migration into many parts of the world, some of them clearly not optimal. Until quite recently, there was still ample room for expansion into areas where climate did not pose intolerable problems and where food, water, and shelter were available at reasonable expenditures of effort. Now such unoccupied territory is not easily found, and further increases in human population will cause greater population density, which will pose ever more severe demands on the readily available resources. An alternative to increasing the effi- ciency of utilization of present resources is the development of a means of living satisfactorily in areas where human habitation is now restricted by shortages of food or water or climate extremes of heat or cold. Thus, for example, much effort is currently devoted to making sea water potable and usable for irrigation, and to increasing the efficiency of harvesting food from the ocean, which itself is coming under increasing threat as a result of overfishing and unforeseen consequences of fish farming. As a result of such developments, there is a contentious debate about the Earth’s carrying capacity. The limiting factor is fresh water. This issue will be addressed further in chapter 7.

Physical Environment

The physical environment has been traditionally viewed as the natural environ- ment that includes geological structures, the topography, temperature, humidity, precipitation, solar radiation, air quality and composition, audible sound, and water availability, quality, and composition. However, in a more contemporary sense, our physical environment has also come to include built environments, such as buildings, industries, farming and mining communities, parks, playgrounds, and transporta- tion modalities in which we live, work, and travel. Human settlements take many forms, some more conducive to good health, others less so. We examine the commu- nity foundations of public health in chapter 4, but within the domain of built envi- ronments it is also clear that we have created a wide range of micro-environments, which give rise to physical challenges to good health.

There are numerous examples of buildings and other enclosed spaces that have been constructed, ventilated, heated, or cooled in a manner that has contributed directly to outbreaks of diseases. Environmental health scientists in recent decades have focused on exposure to substances that cause chronic illnesses, such as pulmo- nary disease, cancers of various types, birth defects, and neurological disorders. The exposures have tended to be inanimate—chemicals, noise, and dusts—although organic exposures also play important roles, and all such influences may be con- founded by factors that affect individual susceptibility. Examples of such work includes studies of air pollution associated with respiratory symptoms, impaired lung function, and aggravation of asthma; specific pesticide exposures associated with cancer, stillbirths, and birth defects; and lead exposures associated with declines in mental acuity among children.

Community studies of air pollution have documented that there are highly suscep- tible individuals within communities, such as older adults and individuals with pre- existing chronic conditions such as asthma and heart disease, who will be more likely to be hospitalized during periods of high levels of air pollution. Similarly, exposure to airborne hazards can be aggravated by ergonomic factors, such as level of exertion, rate and depth of breathing, and physical stature, while underlying immune condi- tions and personal habits such as smoking also can render some individuals more susceptible than others.

The physical environment also contributes greatly to the propagation and trans- mission of infectious agents and has long been studied from this perspective. As a result of such work, housing conditions are now widely used as a socioeconomic indicator of health: poor housing quality and overcrowding are associated with poverty and increased vulnerability to disease. For example, poor air quality within homes as a result of inadequate ventilation and presence of mold and smoke con- tribute to poor respiratory health in general and are implicated in the spread and/ or outcome of tuberculosis.1 The same principles of indoor air quality also apply to

large buildings: Legionnaire’s disease is a classic example of this, as is described in one of the case studies in this chapter.

Social Environment

The social environment includes all things involved with the organization of peo- ple, for example, politics, economics, culture, religious faiths, philosophies of life, and occupations. A few thousand years ago, small bands of humans roamed for- ests and fields, subsisting on hunting and food gathering. Gradually this economic pattern was largely supplanted by planting and harvesting and the husbandry of

domesticated animals. The development of these technologies greatly increased the carrying capacity of desirable acreage and, as land values came to reflect this and social systems appeared, human populations increased. Global population growth since the late 19th century (chapter 5) has been attributed mostly to improvements in nutrition, child survival, and sustained high birth rates.

Specialization of function within evolving economies was accompanied by devel- opment and growth of urban communities and the expansion of commerce. The process of urbanization was vastly accelerated by the industrial revolution and is continuing for reasons related to the complex nature of postindustrial societies. Human diseases evolved and changed as the pattern of life changed, as described in chapter 1.

Living in one place has the major disadvantages that things that were chasing you have a chance to catch up and things that you used to leave behind accumulate. Thus, in the history of diseases, early settlements provided an environment where disease agents formerly encountered occasionally and accidentally became adapted to the human condition and became common. Disease vectors and some animal reservoirs for microbial pathogens adjusted to life around human habitation. Certain animals that actually or potentially harbored disease agents pathogenic for man were domes- ticated, or otherwise became symbiotic with human settlement, thereby increasing the probability that those agents would be transmitted to and sometimes from people. Social factors that influence disease patterns include occupation, socioeco- nomic status, the cultural milieu (e.g. food preferences, religious practices, beliefs, and attitudes), and the network of family, friends, and working groups to which individuals belong. These factors influence disease patterns in populations through altering exposure to agents of disease and injury or by altering susceptibility when individuals are exposed to hazards.

Measuring Health

The definition and measurement of health has evolved not only with greater under- standing of disease, the risk factors for disease, and their underlying determinants, but also with an increasing emphasis on well-being even when individuals are living with chronic and disabling conditions, by acknowledging the importance of mental and emotional health as well as physical diseases (chapter 1). This shift has allowed public health professionals to move beyond solely focusing on disease prevention to embrace the broader principles of health promotion. New concepts of health are emerging, and these, too, require measurement.

In order to appreciate disease prevention as an approach to health, one must develop an understanding of the natural history of disease (chapter 6). Central to this is a system of classification. What is disease? The word disease itself derives from “dis-ease” meaning the opposite of ease or comfort. It implies any departure from good health, or from normal physiological or psychological function, and therefore also encompasses “disorders.” Operationally, disease is defined by clinical, pathologi- cal, and epidemiological criteria that enable systematic study and application. As discrete entities, diseases and disorders have been organized within classification sys- tems into categories—infectious, chronic noninfectious, traumatic, psychological— then subclassified into specific conditions.

Measuring health in populations requires use of uniform indicators for the pur- pose of comparing health across different communities. The most basic indicators are based on births, deaths, illnesses, and injuries. As knowledge advances, classification revisions are updated; for example, the World Health Organization’s International Classification of Diseases (ICD) is in its 10th revision, with development of the 11th revision in process. Other bodies contribute, such as the International Health TerminologyStandardsDevelopmentOrganization(IHTSDO),whichfocuseson clinical terminology for health records management, and the American Psychiatric Association, which provides the Diagnostic and Statistical Manual of Mental Disorders (DSM). Comparability of categorizing deaths by cause is accomplished through the International Classification of Disease (ICD) coding system (chapter 1). In recent decades new efforts have been made to define and measure health per se, not only inversely by measures of morbidity, mortality, and life expectancy, but also through means such as self-assessed health status, quality of life,2 and happiness and indirect measures such as income inequality.

Health Information Systems

Many aspects of public health require analysis on an ongoing basis. Detailed descrip- tions of how to approach assessing the health of communities and of larger popula- tions, including the topic of health indicators, are presented in chapters 4 and 5.

Evidence-Based Public Health

Evidence-based public health is defined as the development, implementation, and evaluation of effective public health programs and policies by applying principles of scientific reasoning, including systematic uses of data and information systems, and appropriate use of behavioral science theory and program planning models.4, 5, 6

Standards of Evidence

The call for evidence-based7 disease prevention and health promotion has trig- gered an international debate among researchers, practitioners, health promotion advocates, and policy makers on what should constitute standards of evidence for public health interventions. Such standards are needed to avoid invalid conclusions about the outcomes of intervention trials (internal validity) or about the expected outcomes of interventions when implemented in different sites, settings, and cul- tures (external validity or generalizability). In the interest of the targeted popula- tions and cost-effectiveness of programs, evidence should meet the highest possible standards.

In evidence-based medicine, the randomized controlled trial (RCT) is widely accepted as the “gold standard” and the best strategy to reduce the risk of invalid conclusions from research. Nevertheless, in prevention, health promotion, and pub- lic health research, the RCT has limitations. The design is appropriate for studying causal influences at an individual level using interventions in a highly controlled context. However, many disease prevention, health promotion, and other public health interventions address people within group settings, such as schools, compa- nies, communities, or larger population groups (states, countries). Some studies have used randomization of school classes and whole schools; however, such designs have their own methodological challenges, can be difficult to conduct, and often require long-standing relationships between researchers and the groups involved.

Therefore, other research designs, such as quasi-experimental studies and time-series designs, are also considered valuable strategies for developing the evi- dence base in public health. These research strategies have been used successfully to evaluate the impact of national legislation and policy measures to reduce the use of alcohol, tobacco, and illicit drugs. In certain situations, qualitative studies are also necessary to obtain insight into facilitating factors and barriers to developing and implementing effective programs and policies. For the sustainability of programs in communities, use of qualitative methods can increase the likelihood that proper commitment to program success is in place before implementing a program.

To increase the evidence base needed to ensure programs will be successful in new communities or among different populations, priority needs to be given to replica- tion studies across communities and countries. Such studies are needed to under- stand what role variation in cultural and economic conditions plays when similar interventions are implemented in new settings. They also help identify which adap- tations are needed in such settings to maintain outcomes found earlier. Most of the current public health and prevention research has been implemented in developed countries, especially in the United States. To a large extent the accessibility and use of evidence-based interventions and prevention knowledge worldwide may be ham- pered if such programs are not adapted to other situations. This said, it is impor- tant that public health researchers and practitioners also value the research that is increasingly carried out in developing countries, and the emergence of a literature that caters to this, especially because what is relevant varies with the health situa- tion of particular countries. For example, the “10/90 gap” refers to the finding of the Global Forum for Health Research that only 10% of worldwide expenditure on health research and development is devoted to the problems that primarily affect the poorest 90% of the world’s population.8 Another underlying principle also applies: lessons learned from developing countries can be of value to developed ones as well (e.g., large-scale field trials of vaccines and micronutrients, related health systems research). Being able to locate and assess research from many parts of the world is an increasingly valuable asset for public health everywhere.

In the adoption of evidence-based prevention programs and the international trend to promote “best practices” across countries and communities, questions arise about the appropriate standard of evidence that needs to be available in order to decide about their adoption, reimplementation, or large-scale implementation.9 It is difficult to provide general rules for such decisions that are valid across countries because of differences in cultural practices, health literacy, and economic circum- stances. For further discussion of this and the challenges of “scaling up” interven- tions and sustainability see chapter 4.

Aim of Evidence-Based Practice

The aim of evidence-based practice is to improve preventive and health promotion practices, patient care, and health care delivery and to contain costs by demonstrat- ing the links between interventions and health outcomes and by continuous moni- toring of program outcomes. Evidence-based practice was originally developed in clinical medicine to provide clinicians with information about therapies that work and those that do not. Although the need for evidence-based practice is now widely accepted, it was not until 1952 when the randomized controlled trial appeared in a publication about the value of streptomycin in the treatment of pulmonary tubercu- losis.10 This approach provided the medical community with an experimental design that could be used in applied medical research, and it opened a new world of evalu- ation and control that has extended beyond application to selection of the most effective and efficient therapies to encompass evidence-based public health. British epidemiologist Archie Cochrane set out the principle that because resources would always be limited they should be used to provide equitable distribution of forms of health care shown to be effective using randomized controlled trials. He further suggested there be a critical summary of all relevant randomized controlled trials. This challenge led to the establishment of an international collaboration to develop a database on perinatal trials. Following his death in 1988 and named in his honor, this led to the opening of the first Cochrane Center in 1992 and the founding of The Cochrane Collaboration in 1993. The Cochrane Collaboration is an international network of people helping health providers, policy makers, patients, advocates, and caregivers make informed decisions about health care. The Cochrane Library pro- vides over 4000 reviews that are updated and accessible (www.cochrane.org).

In 2010, the first joint Colloquium of the Cochrane and Campbell Collaborations was held in Keystone, Colorado. The Campbell Collaboration is a comparable inter- national effort founded in 2000 to prepare, maintain, and disseminate systematic reviews of the effects of social interventions in education, crime, and justice and social welfare. Systematic reviews are designed to assess the best available evidence on a specific question through synthesis of the results of studies. Studies are screened for quality and include clear inclusion/exclusion criteria, a specific search strategy, systematic coding and analysis of included study, and a meta-analysis.

Shifting from evidence-based medicine to evidence-based public health requires recognizing different operational realities and therefore incorporating some differ- ent principles. Public health research involves more quasi-experimental studies and is less likely to have many randomized controlled trials to evaluate. The interventions involved tend to take longer than those in clinical medicine, and the training of those conducting them in local settings is often less formal than in clinical medicine, sometimes with no formal certification required, particularly when conducted by voluntary organizations and community advocates who have particular interest in a specific cause. To address some of these fundamental differences in the United States, the Guide to Community Preventive Services was developed under the leadership of the federally appointed Community Preventive Services Task Force. The Task Force oversees systematic reviews led by Centers for Disease Control and Prevention (CDC) scientists to consider and summarize results of systematic reviews, make rec- ommendations for interventions that promote population health, and identify areas within the reviewed topics that need more research. The Task Force was established in 1996 by the US Department of Health and Human Services (DHHS) to develop guidance on which community-based health promotion and disease prevention interventions work and which do not. Systematic reviews involve identifying rel- evant intervention studies via a clearly defined search strategy, assessing the quality of the studies identified by using established criteria, and summarizing the overall evidence of effectiveness and applicability (which may vary enormously by setting) of the interventions being reviewed.

The potential benefits of evidence-based public health decisions include program planners having access to a wide range of interventions that are documented to be effective and, where possible to determine, were deemed cost-effective as well. Fewer resources will be wasted on programs that are not effective, and in the long term, community health outcomes will be improved. The implementation of fewer but more effective programs will also aid in institutionalization of public health practice on a national level and may serve to reduce the wide variation in public health deliv- ery systems that currently exists. Topics reviewed to date include adolescent health, alcohol, asthma, birth defects, cancer, diabetes, HIV/AIDs, sexually transmitted infections and pregnancy, mental health, motor vehicle injuries, nutrition, obesity, oral health, physical activity, social environment, tobacco, vaccines, violence, and worksite health. Evaluation of the utility of this approach for community organi- zations and public health professionals is needed to determine whether there is increased use of the interventions that have been determined to be effective through the systematic review approach. Other countries also have comparable systems for assessing evidence as applicable in their contexts (e.g., in Canada the National Collaborating Centre for Methods and Tools, at McMaster University).11

Community-Based Participatory Research

Traditional approaches that use outside experts and develop interventions that do not adequately address the context in which they are being delivered have led to disappointing results and probably have led to increased demands by community leaders and residents for more truly collaborative approaches (see Chapter 4 on community participation).12 Community-based participatory research (CBPR) is a collaborative process of research involving researchers and community representa- tives; it engages community members, employs local knowledge in the understand- ing of health problems and the design of interventions, and commits community members to the processes and products of research. In addition, community mem- bers are invested in the dissemination and use of research findings and ultimately in the reduction of health disparities.13 The approach has historical roots in devel- opment programs in emerging economies, where programs designed without input from those affected tended to be unsuccessful.

CBPR is a collaborative research process that recognizes the unique strengths of all participants and begins with a research topic of importance within a commu- nity. It aims to combine knowledge and action for social change to improve com- munity health and to eliminate health disparities. Key elements of the approach are that it is participatory; it is cooperative, involving community members and researchers contributing equally; it invokes a colearning process; it involves sys- tems development and local community capacity building; it is empowering for participants and leads to increased control for participants over their lives; and it achieves a balance between research and action. CBPR is an approach to social change, and while research is one part of the process, it is not the only one. For this reason it is sometimes referred to as “action research.” There are three main goals in CBPR: learning knowledge and skills relevant for the program; devel- oping relationships; and engaging in actions that are successful and that build self-sufficiency.

Competencies in Public Health

The preceding sections reveal that public health professionals need to acquire a range of knowledge, values, and skills so as to be capable of working with professionals from a wide range of disciplines. This multidisciplinary science base has also been orga- nized by the profession into core competencies, so as to provide guidance for how it can be integrated within the design and assessment of training programs. It is for this reason that core competencies are now presented in this chapter. Contemporary education in public health is now substantially guided by core competencies; this integrates and expands on the traditional approach of addressing component disciplines separately.

In fact, this is becoming a global movement: public health professionals in many parts of the world are recognizing the need to specify the core competencies required for a trained public health workforce appropriate to their settings. In part this reflects the growing professionalism of the field in response to the increasing complexity of some public health issues. There is also recognition that many people enter this field from other areas of the health profession or even from outside the health professions, with clinical, management, or research backgrounds but without preparation in disciplines essential to competent public health practice. In some tra- ditional settings it is common for individuals to be promoted based on seniority or even political consideration. A key need everywhere is to advance the public health human resource on the basis of professional competence.

This move to define public health core competencies is taking place in several parts of the world; it can be considered a work-in-progress everywhere it is taking place. In Canada, the competencies include public health sciences, assessment and analysis, policy and program planning, implementation and evaluation, partnership, collabo- ration and advocacy, diversity and inclusiveness, communication, and leadership.14 Themes proposed for competencies in Europe are similar but worded differently. Grouped into themes, they include methods (epidemiology and biostatistics; quali- tative); social environment and health; physical, chemical, and biological environ- ment and health; health policy, organization, management and economics, health promotion and prevention, cross-disciplinary themes including strategy making; ethics and related themes.15

The purpose of this movement is to help guide the health human resource devel- opment efforts that are vital for public health organizations to achieve their aim to protect and promote the health of populations. For more detailed illustration, the approach being taken in the United States is relevant. The US approach rec- ognizes three tiers of skill from entry level to senior managers across eight key domains, within which are defined specific professional and technical skills. The first tier applies to public health professionals who carry out day-to-day tasks of pub- lic health organizations and are not in management positions. Responsibilities of tier one professionals include basic data collection and analysis, fieldwork, program planning, outreach activities, programmatic support, and other organizational tasks. Tier two competencies apply to individuals with program management and supervi- sory responsibilities and may include program development, program implementa- tion, program evaluation, establishment and maintainence of community relations, management of timelines and work plans, and presentation of arguments, and rec- ommendations on policy issues. Tier three competencies apply to senior manage- ment and leaders in public health organizations responsible for managing major programs or organizational functions, setting strategies and vision, and building the organizational culture, and they typically have staff reporting to them. The domains addressed are analytical assessment skills, policy development and program planning skills, communications skills, cultural competency skills, community dimensions of practice skills, public health science skills, financial planning and management skills, and leadership and systems thinking skills. Examples from each domain and the expected competency by tier are presented in Table 2-1.16 These efforts to define core competencies are also supported by an evolving range of other documented guide- lines and assessment toolkits that go beyond the scope of this limited introduction.

In the United States, the Association of Schools of Public Health includes five core disciplinary areas (discussed in chapter 1) which must be present for institutional accreditation purposes (biostatistics, environmental health sciences, epidemiology, health policy management, and social and behavioral sciences) and, in addition, an integrated interdisciplinary, cross-cutting set of overall competency domains (com- munication and informatics, diversity and culture, leadership, professionalism, pro- gram planning, public health biology, and systems thinking).17 Although training requirements differ across countries, there is substantial similarity in the profes- sional training needed for developing a competent public health workforce in all countries.

Conclusion

The knowledge base that contributes to development of successful public health programs is constantly undergoing change. Through critical review of the underly- ing science and the evolving knowledge base, public health professionals are able to develop more effective prevention programs. Using the evidence-based public health program approach coupled with a community participation, it is possible to modify programs as needed, ensure that successful programs continue, and eliminate unnec- essary programs while ensuring sustainability of public health programs and policies within communities. Training of public health professionals needs to focus on core competencies so that professionals can apply their knowledge and skills to changing public health challenges.

CASE STUDIES—Sciences in Search of Effective Public Health Interventions

infectious diseases was established as an agency of the League of Nations, was it possible to 15

Case Study: Biological Sciences in Disease Control

Smallpox Eradication

One of the most frequently cited examples of the application of biological sciences to

control human disease is the eradication of smallpox.

18, 19, 20

The possibility of eradicating smallpox was first raised by Jenner himself in 1801 (see

chapter 1) and in the same year Carl, in Prague, advocated smallpox eradication by a com-

bination of surveillance and vaccination. Not until 1923, when an international register of

begin to understand the geographic extent of smallpox.

Many countries failed to report so it was not until 1946 when the World Health Organization replaced the earlier organiza- tion that most countries of the world began providing regular reports of the occurrence of smallpox.15 In Europe, countrywide elimination of endemic smallpox was achieved between 1930 and 1950 and by 1958 endemic disease was eliminated from that continent.15

Progressive increases in the number of smallpox-free countries were seen in the Americas and in Asia, but there was little change in Africa and the Indian subcontinent.15, 17 In 1958 a Soviet delegation to the World Health Organization proposed worldwide eradication of smallpox; the proposal was approved by the World Health Assembly the following year.15 Between 1959 and 1966, further gains in smallpox-free countries were made in South America and Asia, in particular the Peoples’ Republic of China, but smallpox was rampant in the Indian subcontinent and in most of Africa.15, 17 In 1967 the Intensified Smallpox Eradication Programme was established by WHO with the goal to eradicate smallpox in the next decade.15 A Smallpox Eradication Unit was established at WHO in Geneva, funding was supplied by a regular budget, and a young American public health worker, D. A. Henderson, was appointed chief of the Unit.15 The Unit first surveyed the incidence of endemic smallpox worldwide, assessed the quality and quantity of smallpox vaccine, especially in endemic countries that were mostly in the tropics, and assessed the effectiveness of national smallpox eradication programs in the endemic countries.15

Smallpox, at the time, was endemic in 33 countries, with imported cases reported in another 11 countries. The number of reported cases was 131,697, believed to be about 1% of the actual cases.15, 17 Methods were available for large-scale production of a good freeze-dried vaccine, which provided transport and storage without requiring refrigera- tion. However, many endemic countries were using liquid vaccine whose stability under tropical conditions allowed perhaps 15–20% of the vaccine used in the field to be of accept- able potency.15,17 Under the leadership of Dr. Isao Arita, from Japan, the WHO Smallpox Eradication Unit undertook a major campaign to upgrade the quality and increase the quantity of the vaccine.15, 17 By 1970 a majority of the vaccine used in both developed and developing countries met WHO established standards for quality. Regional priori- ties were established by the Smallpox Eradication Unit.15 West and Central Africa were targeted, and the program reached an effective conclusion by 1970.15 Assistance was pro- vided to Brazil and smallpox eradication was successful by 1971.15 Indonesia also received assistance to repeat what had previously been accomplished in 1937. The major attention of the program then focused on the Indian subcontinent.15, 17

The approach taken to control importation of cases was intensive efforts to identify cases and to provide what is called “ring vaccination” of contacts.15 This term refers to vac- cination of all susceptible individuals in a prescribed area around an outbreak of an infec- tious disease: the concept is to form a buffer of immune individuals to prevent its spread. However, the early WHO global eradication policy and that of countries with endemic cases was to rely on mass vaccination with the expectation of 80% of the populations being vaccinated, thus disrupting the transmission of smallpox. The strategy did not work in densely populated countries such as India and Indonesia and would not work unless the 20% of unvaccinated persons were not randomly distributed throughout the popula- tion.15 Therefore the strategy of the Smallpox Eradication Unit shifted to the intensive case-finding and ring vaccination approach, which has become known as “surveillance and containment,” while maintaining an emphasis on mass primary vaccination. Eradication of smallpox was achieved in Indonesia in 1972, in Afghanistan and Pakistan in 1973 and 1974, respectively, and in the rest of the Indian subcontinent in 1975. Progress was steady in Africa so that by early 1976 Ethiopia remained the only endemic country in the world, with some cases imported to Somalia and Kenya from Ethiopia.15 With the war between Ethiopia and Somalia, hundreds of thousands of refugees poured into Somalia and while the last case of smallpox occurred in Ethiopia in August, 1976, in September that year there was an epidemic in Mogadishu, the capital of Somalia.15 The last case of endemic smallpox in the world was a hospital cook in the town of Merka, Somalia.15

A number of factors, some biological and some social, made the eradication of small- pox possible with a major effort of international collaboration; these are also relevant to the consideration of other potential eradication initiatives for comparable infectious diseases. The biological conditions were: the disease was severe with high mortality and serious side effects among survivors’ there were few cases of subclinical infection, that is, if someone had the disease it could be diagnosed, cases became infectious at the time of the onset of a rash so the infectious period was evident, there was no recurrence of infec- tivity, there was only one serotype of the virus so new vaccines did not need to be devel- oped over time, an effective and stable vaccine was developed that could be transported in many climatic conditions without loss of potency, and there was no animal reservoir for the virus. The social and political conditions were that earlier countrywide eradication showed that global eradication was attainable, there were no social or religious barriers to recognition of cases, the costs of quarantine and vaccination for travelers provided a financial incentive for wealthier countries to support the program, and the Intensified Smallpox Eradication Unit of the WHO had inspired and inspiring leaders and enlisted devoted public health workers. The program involved active participation of laboratory scientists (virologists), physicians, nurses, epidemiologists, biostatisticians, policy mak- ers at local, national, and international levels. Thus, public health workers and health care providers worked as a global team over a long period to successfully implement an ambitious campaign to eradicate smallpox.

Case Study—Understanding the Life Cycle of a Vector to Design Control Measures

Malaria

In 2006 there were an estimated 247 million cases of malaria among the 3.3 billion peo- ple at risk.21, 22, 23,24 Approximately one million deaths occurred annually, mostly among children under 5 years of age.21 In 2008 there were 109 countries endemic for malaria, 45 within the African region of the World Health Organization.2

Public health officials at the beginning of the twentieth century were divided among those who advocated mosquito control and those who called for eliminating the parasite within human hosts.19, 20 Vector control programs focused on elimination of the breeding sites through drainage and by spreading oil on water surfaces to destroy larvae.19, 20 Adult mosquitoes were killed with pyrethrum sprays.20 Quinine was used to destroy parasites but, while effective in reducing symptoms of malaria and mortality, it did not eliminate the gametocytes that infect mosquitoes so did not reduce transmission. 20 Figure 2-2 shows the lifecycle of the malaria parasite.

In the United States during World War II, there was rapid development of synthetic chemical pesticides in order to support the health of military troops in tropical areas of the world.19, 20 The most notable development for vector control was dichloro-diphenyl- trichloroethane (DDT).20 DDT was first synthesized in 1874 by Othmar Zeidler, a German student, but the insecticidal properties were not described until 1939 by Swiss chemist Paul Muller.19, 20 In 1942, the US Department of the Army began experiment- ing with DDT and discovered the immense military possibilities in controlling insects that impeded war efforts. The need to control lice, which carried typhus, and mosquito species that carried malaria, yellow fever and dengue was pressing. Having identified the potential of DDT to control insects causing diseases among military personnel raised a demand for a production system that could produce large quantities of the synthetic compound. DDT retained its toxicity for months; therefore spraying only once every six months was required and when sprayed on walls sometimes only once a year. Human toxicity was very low so the compound was widely adopted. Allied forces reduced typhus and malaria among troops in the Pacific using DDT.19

During the 1955 Eighth World Health Assembly in Mexico City, the assembly was asked to ratify a proposal to use DDT to eradicate malaria by targeting killing female anopheline mosquitoes.21 The program involved four strategies: (1) epidemiological study of the charac- teristics of the disease in order to develop an intervention plan; (2) indoor spraying of DDT on the walls of every house or hut in which humans slept based on the assumption that female anopheline mosquitoes fed primarily indoors while people were sleeping ; (3) screen- ing of infants and active case finding and treatment to eliminate remaining cases after the number of infective human carriers was zero or close to zero with continued surveillance for countries certified as free of malaria to prevent reintroduction from neighboring countries; and (4) continuation of the program until global eradication was achieved.21

By the early 1960s, elimination of malaria on all continents except Africa seemed in sight.21 By the 1970s, a total of 26 (56%) of the countries that had initiated the eradica- tion campaign were successful.21 The WHO abandoned the eradication strategy in 1969, shifting back to a policy of mosquito control.21 Widespread DDT resistance in anoph- eline mosquitoes led public health officials to turn to organophosphate, carbamate and pyrethroid insecticides, which were more costly than DDT.21 Environmental concerns about the persistence of DDT in the United States and other developed countries led to banning use within country borders and increased the cost of insecticide control of mos- quitoes.21 Antimalarial drug resistance was also cited in the failure to eradicate malaria in tropical and subtropical regions of the world.21 In countries where eradication had not been achieved, cases rebounded during the 1970s and 1980s.17, 21

In 1998, a new program operating under the slogan “Roll Back Malaria” was launched by the world public health community.21 The program was centered on a series of spe- cific interventions, largely shown to be effective in reducing mortality among children. Cost-effective, sustainable approaches were emphasized with particular focus on the use of insecticide-treated bed nets in highly endemic areas. Intermittent preventive therapy with antimalarial drugs to protect women during pregnancy was also endorsed, as was early detection and treatment of children with fever. The program also endorsed engage- ment of a wide range of government ministries (a multisectoral approach) and called for reinforcement of basic health services.21 The goal of the program was to reduce the global burden of malaria by half by 2010 and by 75% by 2015.21 The program involved a public-private partnership including chemical and drug companies, and it employed a range of methods (acquire and properly use bed nets, seek antenatal care and follow preventive regimens, recognize symptoms of malaria, and obtain medical care for chil- dren with fevers). The success of the program is being constantly monitored.21 According to the World Malaria Report 2011, issued by the World Health Organization, malaria mortality rates have fallen by more than 25% globally since 2000, and by 33% in the WHO African Region.24 The report states that progress is the result of a significant scaling-up of malaria prevention and control measures in the last decade, including the widespread use of bed nets, better diagnostics, and a wider availability of effective medicines to treat malaria.

Case Study: Built Environment and Transmission of an Infectious Agent

Legionnaire’s Disease

In July, 1976 a common-source outbreak of pneumonia affected people attending the 58th annual convention of the American Legion, Department of Pennsylvania in Philadelphia.25, 26 The epidemic was first recognized on August 2, 1976.23 An epidemio- logic investigation of the outbreak determined that the disease was most likely airborne and focused on one of the convention hotels, which subsequently closed because of defective air conditioning equipment, implicated in the investigation.23 The specified period of time for this epidemic was July 22 to August 3, 1976.23 Of 182 persons who became ill, 147 (81%) were hospitalized and 29 (16%, the case fatality rate) died.23

About six months later the etiologic agent, a Gram negative bacillus (Legionella pneumophilia) was identified for the first time, and the disease came to be known as Legionnaires’ disease because of the association with the American Legion convention.22 The source of the agent was a bacteria circulated throughout the hotel in the ventilation system.22 Public concern about future outbreaks led to the closing of the hotel, which had been a landmark in Philadelphia.22 Since that time, infection with Legionella spp. has become recognized as an important cause of community and hospital acquired pneumo- nia. Legionella spp. are ubiquitous and found in natural aquatic environments (streams, rivers, ponds, lakes, and thermal pools) in moist soil and mud.22 They can survive chlori- nation and therefore enter water supply systems and grow in thermal habitats, including air conditioning cooling towers, hot water systems, shower heads, taps, whirlpool spas, and respirator ventilators.22 Most cases of legionellosis can be traced to man-made aquatic environments and therefore Legionnaires’ disease has become a major concern of public health professionals and individuals involved with the design, construction, or mainte- nance of water systems, including air-conditioning systems, circulating water systems, and cooling towers.22 Prerequisites for infection include the presence of virulent bacte- ria in an aquatic environment, amplification of the bacterium to an unknown infectious dose, and transmission of the bacteria as an aerosol to a human host who is susceptible to infection.22

As a result of this multidisciplinary investigation, legionellosis is now considered a preventable disease though controlling or eliminating the bacterium in air conditioning reservoirs. Identification of the causal agent and mode of transmission required input from a wide range of scientists from the physicians who first diagnosed the cases to the epidemiologists who conducted the outbreak investigation to the laboratory scientists who worked to isolate the organism causing the disease. The work conducted to identify the other reservoirs of the organism included that of environmental scientists, and control of the organism today involves a wide range of public health workers, including engineers, to improve the design of heating and cooling systems. This example also illustrates the role of the economic environment in contributing to the outbreak, since the water cool- ing system used at the hotel was old and probably not well maintained due to financial constraints. In addition, it reflects the social environment: the outbreak occurred during a convention that brought people together from across a nation; this created conditions for widespread distribution of cases, which made tracking them more challenging.

Case Study: Controlling a Toxic Substance Associated with an Industrial Source

Lead Levels in a Canadian Community—Local Example of a Global Issue

Preamble: Any child failing to reach full intellectual potential due to a preventable envi- ronmental cause such as exposure to toxic levels of lead is a tragic loss for the family and for society. Therefore, in many nations around the world, such environmental toxins are being brought steadily under control. For example, in 1999–2000 the US National Health and Nutrition Survey found that the mean blood lead level (BLL) for children 1–5 years in the United States was 2.2 μg/dl. Even so, over 2% of this age group still had BLL above 10 μg/dl, which translated into half a million children at risk of attributable learning dis- abilities and behavioral problems in the United States. The US government set a national goal of eliminating BLL >10 μg/dl among children 1–5 years by the year 2010.27 Although the current level of concern for BLL in children is 10μg/dl, recent studies suggest that even lower levels can be associated with lower test scores.

Our story starts in 1971 in Canada with an investigation into horses with lead poi- soning traced to contaminated pasture near the town of Trail, in the province of British Columbia.28 Recognition of air pollution as an issue in Trail was not new, being the site of a major lead and zinc smelting operation for over 90 years. By the mid-1960s, the company operating the smelter had recognized air pollution as a significant concern to which it must respond.29 As lead exposure, even at low levels, may impair intellectual development, espe- cially early in life, a study of blood lead levels (BLLs) of children aged 1–3 years was carried out in 1975 by the provincial Ministry of Health and Health Canada, revealing elevated levels in Trail (average 22 μg/dl) that were attributed to smelter emissions; elevated levels were also identified from Vancouver and Nelson, in children living near major transpor- tation routes.30, 31 At this time, adding lead to gasoline was the norm for the petroleum industry.

Efforts to reduce lead emissions and exposures accelerated. In 1989, a team from the University of British Columbia sampled children living in Trail, aged 2 to 5 years: their average BLL was 13.8 μg/dl (range 4 to 30 μg/dl).32 While 40% lower than in 1975, this was still much higher than other locations in Canada. Children with high levels tended to live in neighborhoods close to the smelter, and soil levels and house dust were the prin- cipal determinants. However, 39% of children had levels above 15 μg/dl, then defined by the US Environmental Protection Agency (EPA) as a “level of no concern” (later revised as reflected in the preamble). The purpose of the 1989 study was to define a basis for precautions and protection against future lead exposure. Recommendations called for implementing a comprehensive lead awareness and education campaign and provided the impetus for creating the Trail Community Lead Task Force.

The Task Force set two goals: at least 90% of children age 6 to 72 months in neighbor- hoods closest to the smelter should have blood lead levels less than 10 μg/dl by 2005, and at least 99% should have blood levels less than 15 μg/dl by 2005.33 The Task Force com- prised representatives from BC Ministries of Health and Environment, the City of Trail, Cominco Limited, the general public, the local School District, United Steelworkers of America Locals 480 and 9705, and a local network of environmental groups. The Trail Lead Program was the operational arm of the Trail Community Lead Task Force. The two BC ministries, Cominco and the City of Trail, shared responsibility for funding the program. This effort constitutes a case study of community action (see chapter 4) and an early example of public-private partnership in support of public health (see chapter 8).

From 1989 to 1996, blood lead levels in children 6–60 months fell slowly from an aver- age of 13.8 μg/dl to 11.5 μg/dl, an overall rate of decline of 0.6 μg/dl/year.34 Since 1991, the Task Force carried out BLL screening, case management, education programs tar- geted at early childhood groups and the general community, dust abatement, exposure pathway studies, and remedial trials. While some of the decline would have derived from phasing out leaded gasoline from which Trail children would have benefited (like all BC children), BLL improvement from 1989 to 1996 was attributed mainly to the community interventions, especially reducing exposure to contaminated soil and household dust.

From 1996, BLLs fell more rapidly to 5.9 μg/dl in 1999;35 the average rate of decline tri- pled from 0.6 μg/dl per year (1989 to 1996) to 1.8 μg/dl per year (1997 to 1999). This accel- erated reduction was attributed to the start-up in May 1997 of a new lead smelter using modern flash-smelting technology, following which mean air levels fell from 1.1 μg/m3 to 0.28 μg/m3 in 1998, and lead concentrations in outdoor dust-fall, street dust, and indoor dust-fall fell by 50%. Since 1998, yearly ambient lead levels have been substantially below guideline levels set by BC Pollution Control, US Environment Protection Agency, and the World Health Organization.36 By 2007, the goals set by the Task Force were virtually achieved: 89% of children in neighborhoods closest to the smelter had levels of <10 μg/dl and 100% were <15 μg/dl. It may be concluded that the type of smelter technology used for so long in Trail was largely responsible for toxic levels of lead in children, and replacing this was the most important intervention.

This ongoing intervention, and others, now comes under the auspices of the Trail Health & Environment Committee (THEC). In reviewing this story, which is steadily approaching success, it is important to recognize that “averages” do not apply to the experi- ence of individuals whose BLLs fall within a range outside the mean. Given the current norm regarding 10 μg/dl as the level above which neurotoxicity can be clearly demon- strated, in the context of individual variability and susceptibility that apply in the real world, further reductions nonetheless must be achieved; as already noted, even lower levels can be associated with reduced developmental test scores. Thus, the THEC has concluded that BLL testing should be reevaluated and new scope and goals proposed.

It is noteworthy that THEC won a Premier’s Innovation and Excellence Award for Partnership in 2011, recognizing excellence in public service in the areas of leadership, innovation, organizational and service excellence, partnership, and cross-governmental integration.

Note: See chapter 7 for more recent global developments regarding lead exposure.

Case Study of an Indirect Health Effect of a Greenhouse Gas

Chlorinated Fluorocarbons (CFCs) and the Increase in Malignant Melanoma

The role of greenhouse gas (GHG) emissions on climate change and associated impacts on human health are discussed in chapter 9. Many of those impacts, serious as they are, such as the expanding global reach of disease vectors and the displacement of peoples due to rising seawater levels, can be viewed as indirect. However, despite their major importance to the environment and these indirect impacts, GHGs generally do not have a direct impact on human health, with one notable exception: chlorinated fluorocarbons (CFCs). These emissions are responsible for depleting the Earth’s ozone layer.

The earth’s stratospheric ozone layer protects humans from solar radiation, which is important because a causal relationship between sun exposure (particularly Ultra Violet-B radiation) and skin cancers is well-established.38 Attention has been drawn also to the potential for ocular damage.39 Trends in the incidence of melanoma (the most seri- ous skin cancer for which good data are available) in Canada are presented in Figure 2-3, which reveals a steady increase in recent decades.40 This continues to grow as a percentage of all male and female cancers. Other skin cancers, squamous cell carcinoma and basal cell carcinoma, are also associated with UV-B radiation.

The single most important factor affecting UV-B exposure is the amount of ozone in the atmosphere. CFCs are largely responsible for depleting this ozone layer: as much as a 2% increase in UV-B radiation may be expected for each 1% reduction in stratospheric ozone concentration. CFCs were used for decades as propellants in spray cans and as freon gas in refrigerators and air conditioners until a Canadian-led global moratorium on their manufacture and use was adopted in 1987 as The Montreal Protocol on Substances that Deplete the Ozone Layer. To celebrate the success of the first 20 years, countries gathered in Montreal, Canada, in 2007, to recognize the broad coalition of governments, scientific researchers, and others who have developed smart, flexible, and innovative approaches to protecting human health and the global environment.41

Although the treaty has been a great success in curbing CFC emissions, unfortunately, as CFCs have a half-life of about 100 years, ozone depletion from existing CFC contami- nation will continue well into the twenty-second century.42 A global increase in the inci- dence of skin cancers in recent decades has been attributed in part to this phenomenon, because of its role in increasing the intensity of UVB exposures.

The UB-V radiation dose for most individuals is a function of duration of sun exposure, which ranks high among lifestyle behaviors (e.g., sun bathing) occupational exposures (e.g., farming), and other outdoor pursuits (e.g., gardening, hiking). The good news is that most people have a choice in these aspects of the exposure they receive. For example, there is evidence from Australia for a birth-cohort effect consistent with variations in sun expo- sure and the use of protective measures (e.g., protective clothing, sun blocks).43 According to the US National Cancer Institute, such preventive measures may outweigh the effects of decreases in stratospheric ozone.44 Similarly, tanning beds and sunlamps have also been recognized as preventable risks in the causation of melanoma, as well as for other forms of skin cancer;45 increasingly these are being regulated, especially to ensure that the main users (young adults) are advised of the risk and, in some jurisdictions, restricting access to persons under age.

On balance, although it will take a century for atmospheric ozone levels to stabilize, there is reason to view the long-term scenario positively: a potential success story for the environment and for public health. Global action on CFC emissions and local actions on lifestyles will eventually reduce the impact of melanoma and other skin cancer.

Tobacco

The social environments in which we live also profoundly influence our individual choices; these in turn can have a profound influence on the patterns of disease. Our choices are usually made in environments heavily influenced by the availability of accurate, inaccu- rate, and sometimes completely wrong information, as well as by access, culture, and peer pressure. For example, where advertising targets specific groups of people, they are more likely to believe that using certain products will enhance their lives. Tobacco advertising is one such example.

Worldwide, approximately 1.3 billion people currently smoke cigarettes or use other tobacco products.43 The decline of smoking in developed countries, in response to health policy and promotion initiatives, and the increasingly aggressive marketing of tobacco products in the developing world, has shifted the geographic distribution of smoking toward developing countries.43, 44 In 1995, more smokers lived in low and middle income countries (933 million) than in high income countries (209 million).43, 44 An estimated 4.9 million smoking related deaths occurred in 2000, with a projection that in 2020 there will be more than nine million annual deaths, of which seven million will occur in developing countries. To address this pandemic of tobacco related diseases, in 2005 the World Health Organization (WHO) launched the Framework Convention on Tobacco Control.43

WHO also supports a tobacco free initiative that includes surveillance of the preva- lence of its use, identifying its health and economic consequences, assessing social and cultural determinants of its use, identifying tobacco control policies, and monitoring actions of the tobacco industry.45 The approach used to monitor the pandemic and evalu- ate the success of tobacco control programs implemented in different countries incorpo- rates a broad vision of public health and cooperation at the global level.

Tobaccoproductsareassociatedwithnumerousdiseases,includingcancersofthelung, esophagus, larynx, tongue, salivary glands, lip, mouth pharynx, urinary bladder, kidneys, uterine cervix, breast, pancreas and colon, heart disease, chronic obstructive pulmonary disease (chronic bronchitis and emphysema), and peripheral vascular disease (atheroscle- rosis).43 Some evidence also suggests an association between cigarette smoking and osteo- porosis, thyroid problems, and the onset of type-2 diabetes; there is strong evidence that smoking is one of the most powerful factors determining severity of outcomes for all forms of diabetes.43 Smoking cessation programs traditionally targeted current smokers, ignoring the larger social context that encouraged and supported smoking through marketing.

Tobacco products, legal for mainly historical reasons, are the only consumer product that kills half of its regular users.46, 47 The tobacco industry has used economic power, lobbying and marketing, and manipulation of the media to discredit scientific research and to influence governments to propagate the sale and distribution of its product.47 The tobacco industry makes large philanthropic contributions to social programs worldwide, thereby creating a positive image; sponsorship of sports and cultural events also have been widely used by the industry to promote this false image.47 Effective tobacco control is counter to the economic interests of the tobacco industry, associated industries, and stockholders.47

The primary goal of tobacco control is to prevent related diseases and premature death. To accomplish this goal programs are designed to prevent people from initiating tobacco use (primary prevention) and to assist current smokers in quitting (secondary preven- tion). Efforts to reduce exposure to second-hand smoke are included in control measures, with the most effective approach being the prohibition of smoking in public places.45 Additional tobacco control efforts worldwide include prohibitions on advertising and on sponsorship of events, tax and price increases, labeling tobacco products as hazardous, and monitoring illicit trade of tobacco.46

Recognition of the social and cultural context of the populations involved has been a key component of successful control programs. For example, cultural sensitivity is a widely accepted principle in public health. To tailor tobacco prevention programs for specific populations requires acknowledgment that there are differences in prevalence of tobacco use across age, sex, racial, and ethnic groups.48 But there are also different types of smoking patterns across such groups, thus requiring programs to be tailored to address the pattern differences. For example, African Americans are more likely to smoke men- thol cigarettes than other groups, but they and Hispanics are less likely to be heavy smok- ers than whites.48 Information such as this might be used to target programs, but tailoring programs requires focusing on the functional use of cigarettes within different popula- tions.48 Tobacco may be used for socialization in various ways such that peers may play a role different from parents’ in different groups.48 For example, peers have been reported in the United States to have a stronger role on initiation of smoking among whites and Hispanics compared with African Americans.48 Therefore, while using peers as a means to influence behavior may be effective among white and Hispanic youth, it would be unlikely to be effective among African American youth.48 Engaging parents and other adult role models may be a more effective way of designing intervention programs for African American youth.48

This closing case study of tobacco control illustrates why social and behavioral sciences have proven important to understanding such public health challenges and develop- ing relevant and effective approaches to health promotion and disease prevention and control.