As our nation spends an ever-increasing portion of our gross domestic product on health care, the cost threatens to stifle our ability to remain competitive in the world. Americans are generally in poorer health than our counterparts in the developed world. This may be why we spend more than most other countries yet have similar—or worse—health outcomes. It has been observed that we do not operate a "health care" system; instead we operate a "sick care" system. What if we were to rethink our health care system and turn from a primary focus on treatment to a greater focus on preventing diseases in the first place? This could lead to healthier people and, perhaps, improve our current cost problem. Given that we currently spend only 1%-2% of our health care dollars on prevention activities, this would be a considerable change from the way we think about health care.

What if we were to rethink our health care system and turn from a primary focus on treatment to a greater focus on preventing diseases in the first place?

North Carolinians face a myriad of different diseases and conditions. Some of these diseases are benign and will resolve on their own or can be cured with medical intervention. Others are chronic but can be managed successfully. Still others can lead to long-term disabilities or premature death. Many of the leading causes of death and disability in North Carolina are preventable, in whole or in part. The North Carolina Institute of Medicine (NCIOM) Task Force on Prevention was charged with identifying evidence-based strategies to prevent these conditions from occurring or to identify the health problems early in the disease so as to more easily treat and resolve the problems.

The *Prevention Action Plan for North Carolina* includes evidence-based strategies that, if followed, would improve population health in the state. The Task Force followed four steps in developing this plan. First, the Task Force identified the diseases and health conditions that had the greatest adverse impact on population health. Second, the Task Force identified the underlying preventable risk factors which contribute to these leading causes of death and disability. Third, the Task Force examined the literature to identify evidence-based strategies that could prevent or reduce the risk factors. Finally, the work of the Task Force was guided by a socio-ecological model. That is, Task Force members recognized that people do not make health decisions in a vacuum. A person's decision whether to engage in risky health behaviors is influenced by other factors, including the opinions of family and friends, clinical advice, community and environment, and public policies. Through this four-step process the Task Force attempted to identify multifaceted strategies that would support healthy lives on many different levels of the socio-ecological model. Each of these factors is described in more detail below.

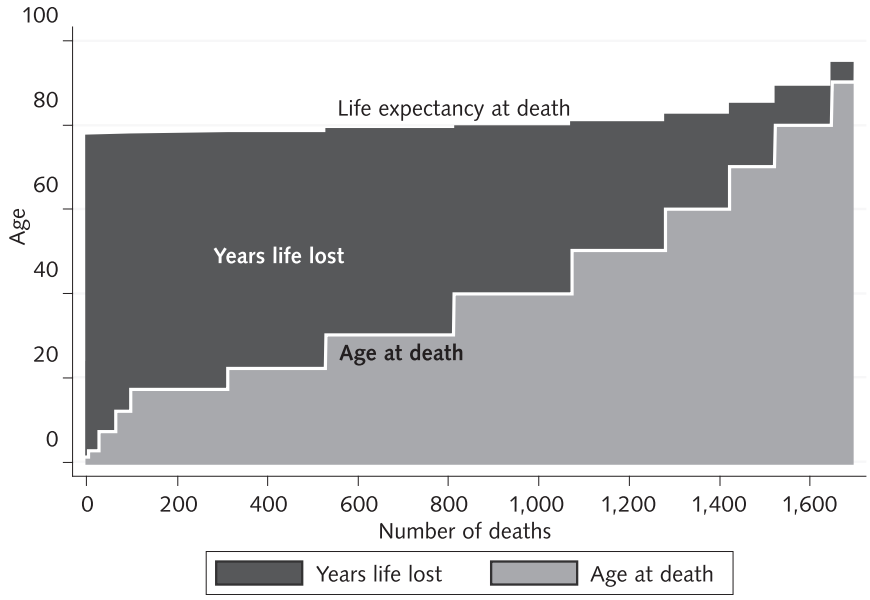
Leading Causes of Death and Disability in North Carolina

The burden of disease can be conceptualized as two distinct elements: death and disability. Death, or mortality, can be measured in multiple ways, including the

total number of deaths by underlying cause, age-specific death rates, and *years of life lost* (YLL). The Task Force chose to use YLL, a calculation that estimates the years of life that a person lost due to early death. For example, a newborn in North Carolina has a life expectancy of 76 years. If that newborn dies, there is a loss of 76 years of life. Similarly, a 50-year old has a life expectancy of 79 years, so someone dying at age 50 loses 29 years of life; the death of a 75-year old (life expectancy of 86) leads to a loss of approximately 11 years of life.[1] Effectively, this approach places more weight on deaths at earlier years. As an example, Figures 2.1 and 2.2 show the YLL for two common causes of death for North Carolinians in 2005: motor vehicle accidents (MVAs) and Alzheimer's. Although there were roughly 30% more deaths due to Alzheimer's than MVAs, the YLLs for MVAs are much higher. This is due to the fact that Alzheimer's occurs primarily in older individuals.

The burden of disease can be conceptualized as two distinct elements: death and disability.

Figure 2.1
Years of Life Lost Due to Motor Vehicle Accidents in North Carolina, 2005



Source: North Carolina Institute of Medicine. Analysis of North Carolina Vital Statistics, 2005.

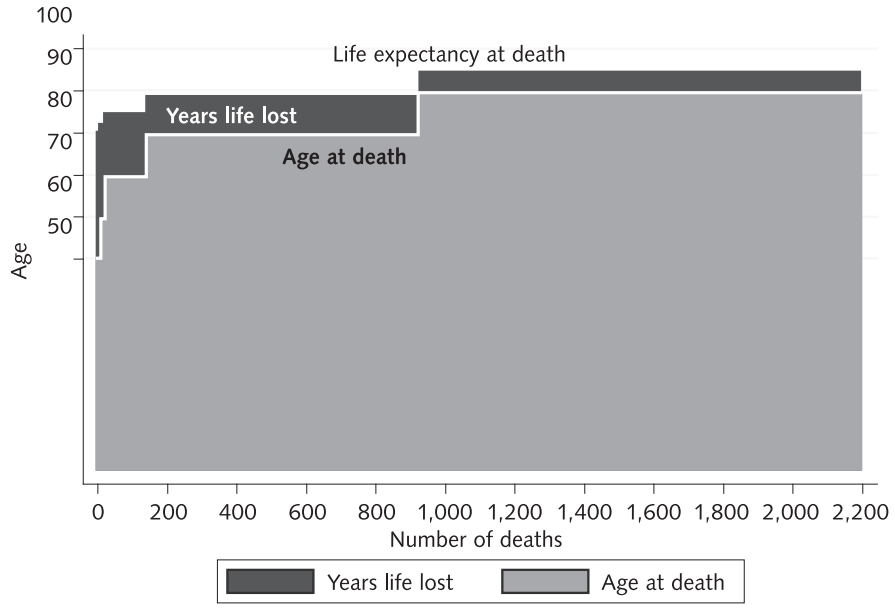
Just as there are multiple ways to measure mortality, there are many ways to measure morbidity. The Task Force chose to measure morbidity as *years of life lost due to disability* (YLD). The measure attempts to quantify the impairments that result from less than perfect health. The term "disability" carries a connotation of being debilitating; however, in this case, disability means a decrease in quality of life, so even common colds carry a disability "weight." Essentially, YLD uses conversion factors to account for the decrease in quality of life resulting from a particular condition, with 0 representing perfect health and 1 representing death. The closer a weight is to 0, the smaller the disability burden. Weights have been

developed using a variety of methods and are most often based on surveys of people with a particular condition.[a] As examples, an ear infection has a disability weight of 0.023, an episode of limiting low back pain is 0.063, an arm amputation is 0.257, and Alzheimer's is 0.66.[2] Using these weights, the duration of time with the condition, and the number of people with the condition, measures of the disability burden on North Carolinians can be developed. For example, four years of limiting low back pain (4 x 0.063 = 0.252) is approximately equal in burden to one year of life with an arm amputation (0.257).

The two measures—YLL and YLD—were developed in concert and can be added together to calculate *disability-adjusted life years*, or DALYs. DALYs measure the overall burden of a disease or condition and include the deaths resulting from it, the disabilities (and duration of those disabilities) associated with it, and the number of people with the particular disease/condition. Although the North Carolina State Center for Health Statistics produces good estimates of YLLs in North Carolina (from death records and life expectancy tables), state-specific data on YLDs are unavailable.[3] However, national data are available.[b,4] The Task Force

DALYs measure the overall burden of a disease or condition and include the deaths resulting from it, the disabilities (and duration of those disabilities) associated with it, and the number of people with the particular disease/condition.

Figure 2.2
Years of Life Lost Due to Motor Vehicle Accidents in North Carolina, 2005



Source: North Carolina Institute of Medicine. Analysis of North Carolina Vital Statistics, 2005.

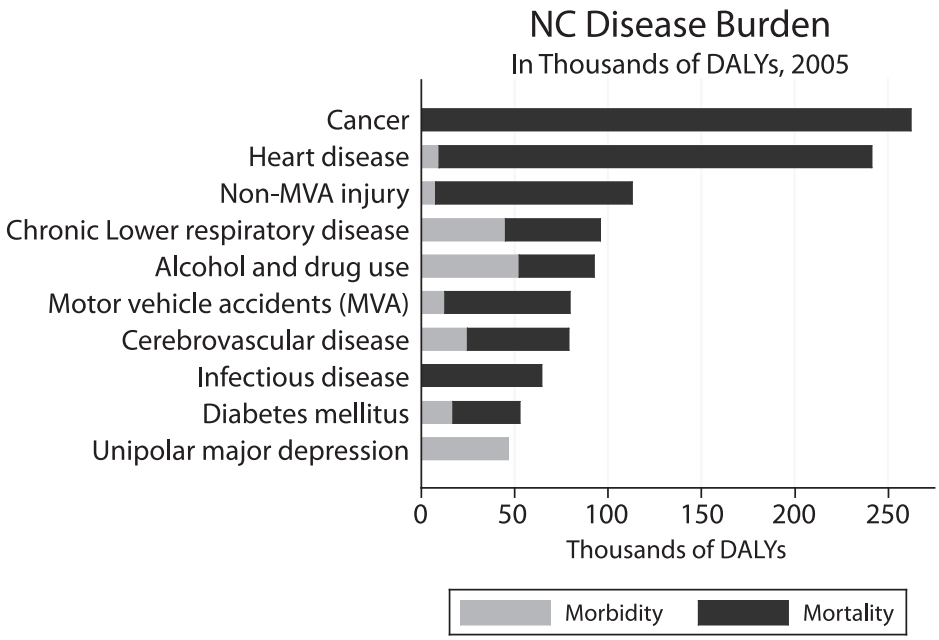
a World Health Organization. http://www.who.int/healthinfo/global_burden_disease/daly_disability_weight/en/index.html

b For this study, the authors used a variety of national data sources (such as hospital discharge data and the National Health and Nutrition Examination Survey data) to estimate the prevalence of diseases and conditions and then applied the Global Burden of Disease disability weights to generate national YLD estimates. See Additional File 2 of Michaud et al. (Population Health Metrics 2006;4:11) available at http://www.pophealthmetrics.com/content/supplementary/1478-7954-4-11-s2.doc).

adjusted the national data to the North Carolina population to develop YLD estimates for the state.[c] Figure 2.3 presents the estimated number of DALYs associated with the top 10 conditions yielding the largest death and disability burdens in North Carolina.

Top 10 diseases and conditions leading to greatest disability adjusted life years in North Carolina.

Figure 2.3
Top 10 Diseases and Conditions Leading to Greatest Disability Adjusted Life Years in North Carolina



Notes: Infectious disease includes pneumonia and influenza. Non-MVA Injury includes unintentional and intentional injuries.

Source: North Carolina Institute of Medicine. Internal analysis of North Carolina Vital Statistics (2005 mortality file); Michaud CM, McKenna MT, Begg S, et al. The burden of disease and injury in the United States 1996. *Popul Health Metr.* 2006;4:11; and literature review of underlying causes of death and disability for each leading cause.

c The national data YLD rates were divided by the national population (in 1996) and multiplied by the North Carolina population (2005); thus, the North Carolina rate was 3.38% of the national rate. This is only an estimate, as it assumes, among other things, a disease prevalence and age structure identical to the national structure in 1996.

Cancer imposes the greatest burden, even without good disability measures, which is due to the lack of an estimated disability burden of cancer.[d] Heart disease closely follows cancer. The combined incidence of cancer and heart disease yields a "cost" of over 500,000 DALYs in North Carolina each year. In terms of morbidity, 500,000 DALYs is equivalent to 6,579 newborn deaths (=500,000/76 years expected life) annually. Other conditions leading to large burdens include chronic lower respiratory disease (such as asthma, emphysema, and chronic bronchitis), intentional and unintentional injuries, alcohol and drug use, motor vehicle accidents, strokes, infectious diseases, diabetes, and unipolar depression.

Underlying Preventable Risk Factors Contributing to the Leading Causes of Death and Disability in North Carolina

North Carolina can do more to prevent premature death and disability by reducing the number of people who engage in or are exposed to certain risk factors or by providing individuals with more health promoting opportunities.

North Carolina can do more to prevent premature death and disability by reducing the number of people who engage in or are exposed to certain risk factors or by providing individuals with more health promoting opportunities. The idea is to move "upstream" to prevent a given health problem from occurring in the first place. Thus, the second step that the Task Force undertook was to identify preventable risk factors which contribute to the leading causes of death and disability. Staff at the NCIOM undertook a literature review to identify the most common preventable risk factors. (See Appendix C.)

Personal behaviors, such as smoking, exercise, nutrition, use of alcohol or drugs, and risky sexual behavior contribute to most of the leading causes of death and disability in North Carolina. For example, tobacco use can contribute to cancer and heart disease, failure to exercise and improper diet can lead to heart disease or diabetes, and use of alcohol or other drugs can contribute to motor vehicle injuries or depression. However, there are other risk factors which also impact individual health status. Exposure to toxic chemicals or other environmental hazards can lead to cancer, while exposure to bacteria or viruses can lead to infectious diseases. Further, lack of education or living in poverty can contribute—both directly and indirectly—to many of the major health problems facing the state. Based on this literature review, the Task Force identified 10 preventable risk factors which contribute to the leading causes of death and disability in the state. (See Table 2.1.) These include the following: tobacco use; poor nutrition and physical inactivity resulting in overweight and obesity; risky sexual behavior; alcohol and drug use; emotional and psychological factors; chemical and environmental pollutants; unintentional and intentional injuries; bacteria and infectious agents; racial and ethnic disparities; and socioeconomic factors.

d Given prevalence rates and disability weights, it would be possible to calculate North Carolina-specific disability estimates. But estimates for other conditions would not be as easy to calculate (due to limited data on prevalence or disability weights), so for comparison purposes the Task Force decided not to develop estimates beyond those included in the Michaud et al. (Population Health Metrics 2006;4:11) study.

Table 2.1
Diseases and Conditions Leading to Greatest DALYs in North Carolina and Their Underlying Preventable Causes

	Tobacco use	Diet, physical inactivity, overweight/obesity	Risky sexual behavior	Alcohol and drug use	Emotional and psychological factors	Exposure to chemicals and environmental pollutants	Unintentional and intentional injuries	Bacteria and infectious agents	Racial and ethnic disparities	Socioeconomic factors
Cancer	✓	✓		✓		✓			✓	✓
Heart disease	✓	✓		✓	✓				✓	✓
Non-motor vehicle injury	✓	✓		✓	✓		✓		✓	✓
Chronic lower respiratory disease	✓	✓				✓			✓	✓
Alcohol and drug use				✓	✓				✓	✓
Motor vehicle injuries (MVI)				✓			✓		✓	✓
Cerebrovascular disease	✓	✓	✓	✓					✓	✓
Infectious diseases				✓		✓		✓	✓	✓
Diabetes		✓							✓	✓
Unipolar major depression				✓	✓				✓	✓

Source: Data from the North Carolina Institute of Medicine literature review.

Given current budget constraints, the Task Force was particularly mindful of the need to use existing dollars more constructively and sought to direct new funding to evidence-based strategies, or when unavailable, best or promising practices.

Identifying Evidence-Based Strategies to Reduce the Preventable Risk Factors or Promote Healthful Behaviors and Environments

Too often in the past we have based our interventions on what we thought or hoped would work, without any real evidence of their efficacy. Or, we might identify an initiative that works in one location and try to replicate it without following the same program structure. These efforts often fail to live up to our expectations and do not produce the results we are seeking.

Given current budget constraints, the Task Force was particularly mindful of the need to use existing dollars more constructively and sought to direct new funding to evidence-based strategies, or when unavailable, best or promising practices. Thus, most of the Task Force's time was spent identifying evidence-based, best, or promising practices that could reduce risky behaviors and lead to better health outcomes.

Essentially, evidence-based programs or strategies are those that have been subject to rigorous evaluation and have been shown to produce positive outcomes.

Typically, an intervention is considered "evidence-based" when it has been subject to multiple evaluations across different populations, when the evaluations include large enough sample sizes to be able to measure meaningful effects of the intervention, and when the evaluations consistently find positive outcomes.[5] The best studies are double-blind randomized control studies, where the individuals who are part of the study ("subjects") are randomly assigned to an intervention or nonintervention ("control") group, and neither the researchers nor the subjects knows which group the subjects are in. Any changes in health status as a result of the intervention can generally be attributed to the intervention because individuals were randomly assigned to a control or intervention group. While considered the "gold standard," randomized control trials (RCTs) are usually more expensive and take a longer time to conduct. Further, it is difficult to test community-wide interventions through RCTs. These types of trials are often used to test clinical interventions.

Evidence-based programs or strategies are those that have been subject to rigorous evaluation and have been shown to produce positive outcomes.

Population-based prevention interventions are often evaluated through other study designs. For example, researchers may use a comparison-group study (examining the outcomes of an intervention in one community with a "matched" group or another community with similar characteristics that did not receive the intervention). Or they may conduct pre-post studies (which measure the changes in the same individuals before and after the intervention). While these evaluation studies are generally less expensive and quicker to conduct, the findings are not as robust as those that come from a well-designed RCT.

The NCIOM Task Force on Prevention began its efforts to identify evidence-based strategies by examining the work of other national organizations that have been charged with reviewing the evidence and making recommendations about clinical interventions, programs, or policies that have been shown to be successful in producing positive health outcomes. For example, the NCIOM Task Force examined the recommendations of the US Preventive Services Task Force (USPSTF) when examining potential clinical interventions.[e] The USPSTF is charged by Congress to identify the screening, counseling, and preventive medications that should be routinely offered to populations in primary care settings. For community and environmental approaches, the NCIOM Task Force relied upon recommendations developed by the US Task Force on Community Preventive Services and published in the Guide to Community Preventive Services (Community Guide).[f] The US Task Force on Community Preventive Services is appointed by the Director of the Centers for Disease Control and Prevention (CDC) to identify evidence-based community-based prevention initiatives.

e The US Preventive Services Task Force studies preventive clinical services and issues recommendations to guide clinical care for a variety of health issues ranging from nutrition to sexually transmitted diseases. http://www.ahrq.gov/CLINIC/uspstfix.htm.

f The Centers for Disease Control and Prevention's Guide to Community Preventive Services (Community Guide) provides information on recommended evidence-based interventions to improve public health and systematic reviews of the evidence behind multiple strategies for major public health issues. http://www.thecommunityguide.org/index.html.

Both of these organizations follow a similar approach in making their recommendations and continue to refine their recommendations based upon new and emerging evidence. They both begin by reviewing all studies that have evaluated a particular intervention. The USPSTF focuses on clinical interventions, whereas the Community Guide focuses on population-based prevention interventions affecting communities or health care systems.[6] Both Task Forces examine the quality of the studies, design suitability, number of studies, consistency of results across multiple studies, generalizability to other populations, and the strength of the findings (i.e. large impact, small impact, no impact).

Neither the USPSTF nor the Community Guide has covered all the topics addressed in the *Prevention Action Plan for North Carolina*. Thus the NCIOM Task Force on Prevention turned to other sources for evidence-based strategies. For example, the US Substance Abuse and Mental Health Services Administration (SAMHSA) identifies evidence-based strategies to prevent or reduce use of alcohol and other drugs.[g] Similarly, the US Department of Education maintains a website of evidence-based interventions to improve educational outcomes.[h] Additionally, there are other national organizations that have examined the evidence and made recommendations for subjects that were not addressed through the USPSTF or Community Guide, including the Institute of Medicine of the National Academies and professional associations such as the American Academy of Pediatrics.

The Task Force also considered promising practices when it was unable to identify either evidence-based or best practices.

Unfortunately, there are not well-researched evidence-based strategies for all of the risk factors identified by the NCIOM Task Force. Some interventions have not yet been subject to sufficient evaluation to draw a definitive conclusion about their effectiveness. The intervention may not have been subject to multiple different evaluations (in different settings), or the intervention may be too new to have been evaluated. In these instances, the Task Force tried to identify best practices—that is, practices where there is scientific evidence to suggest that this intervention *might* be effective. There may be some evidence from the published scientific literature but not a sufficient number or quality of studies to warrant designation as an evidence-based practice. Alternatively, there may have been internal program evaluations or some evidence from public health practice of positive results that have not been published in the scientific literature.

The Task Force also considered promising practices when it was unable to identify either evidence-based or best practices. Promising practices include interventions that may have yielded positive intermediate effects (e.g. changes in knowledge) but have not been tested to determine whether it produced changes in health outcomes (e.g. behavioral changes).[6]

Overall, the Task Force tried to identify preventive services, programs, or policies which had the greatest likelihood of producing positive health outcomes—either

g The US Substance Abuse and Mental Health Services Administration maintains a website of evidence-based prevention, early intervention and treatment programs for substance abuse and mental health. The information is available at: http://www.nrepp.samhsa.gov/.

h The US Department of Education maintains a website of evidence-based programs that have been shown to improve educational outcomes. http://ies.ed.gov/ncee/wwc/.

through reductions in risk factors or improvements in health promoting behaviors. The Task Force focused on the demonstrated or potential *effectiveness* of an intervention in producing the results. When available, the Task Force also considered the *cost-savings* or *cost-effectiveness* of the intervention. Cost-savings measure whether the interventions lead to absolute savings through lower lifetime costs. For example, the costs of providing immunizations to an entire population are more than offset by the savings in health care costs for the people who would have otherwise become sick.[7] Unfortunately, with the exception of immunizations and a few other clinical services such as smoking cessation and aspirin use for high-risk patients, there are few other clinical interventions which have been proven to lower overall health care spending.[8] Sometimes prevention interventions have been shown to produce cost-savings when considering other non-health care related costs. However, most clinical interventions do not lower total expenditures, but rather save lives and improve the quality of life.[8] There is less evidence on the cost-effectiveness for community-based prevention programs; the Community Guide Task Force states in its Community Guide that it frequently finds that:

> "no economic evaluations are available for interventions recommended by the [CDC] Task Force (economic evidence was available for only about half of the interventions recommended by the Task Force as of February 2004, and the available evidence was frequently just a single study)." (CDC Guide to Community Preventive Services, page 459)

The Task Force focused most of its work on identifying strategies that are effective in producing desired health outcomes.

Thus, there is little evidence suggesting that community-based prevention programs lead to a net decrease in health expenditures. But as others have observed, this is not necessarily the most appropriate question; the more important question is whether investment in community-based prevention activities yields a reasonable improvement in health for the cost.[8] Most people would likely agree that the goal of preventive care, services, programs, or policies—or for that matter, any health care intervention in general—should not be to minimize total costs—which would mean providing fewer health care services—but instead to choose those interventions that are most cost-effective. That is, we should spend our health care dollars on interventions that work reasonably well or that are cost-effective.[i] Cost-effectiveness examines the potential health outcomes compared to the investment, with those interventions producing the best health outcomes for the least amount of money considered more cost-effective than those that produced moderate to small outcomes for a lot of money. Unfortunately, few of the evidence-based strategies were evaluated using either cost-savings or cost-effectiveness analysis. Thus, the Task Force focused most of its work on identifying strategies that are effective in producing desired health outcomes.

i The historical benchmark for cost effectiveness is between $50,000 and $100,000 per year of life, roughly the cost of kidney dialysis.(Ubel PA, Hirth RA, Chernew ME, Fendrick AM. What is the price of life and why doesn't it increase at the rate of inflation? *Arch Intern Med.* 2003;163(14):1637-1641. Winkelmayer WC, Weinstein MC, Mittleman MA, Glynn RJ, Pliskin JS. Health economic evaluations: the special case of end-stage renal disease treatment. *Med Decis Making.* 2002;22(5):417-430.) Cost-effectiveness of interventions can thus be divided into four categories: cost-saving, highly-cost effective, moderately cost-effective, and not cost-effective.

Multifaceted Interventions are Key to Changing Population Health

The Task Force recognized that health outcomes are often influenced by personal behaviors and choices.[j] However, people do not act in a vacuum. Their actions are influenced not only by personal preferences, but by family, friends and peers; the advice they receive from their health providers; the broader community in which they live, attend school, or work; and public policies. Essentially, this is a socio-ecological model of health behavior.[9] (See Figure 2.4.) The five levels of intervention considered by the Task Force are the following:

- ***Individual:*** a person's behaviors, attitudes, characteristics, and practices.
- ***Interpersonal:*** a person's family, friends, peers, and others who influence their behaviors and experiences.
- ***Clinical Care:*** a person's doctors and other health professionals whose care impacts their health and well-being.
- ***Community and Environment:*** a person's school, neighborhood, church/synagogue/mosque, where social interactions occur, as well as the built environment, weather, and community design which many influence health.
- ***Public Policies:*** policies at the local, state, and national level that influence health.

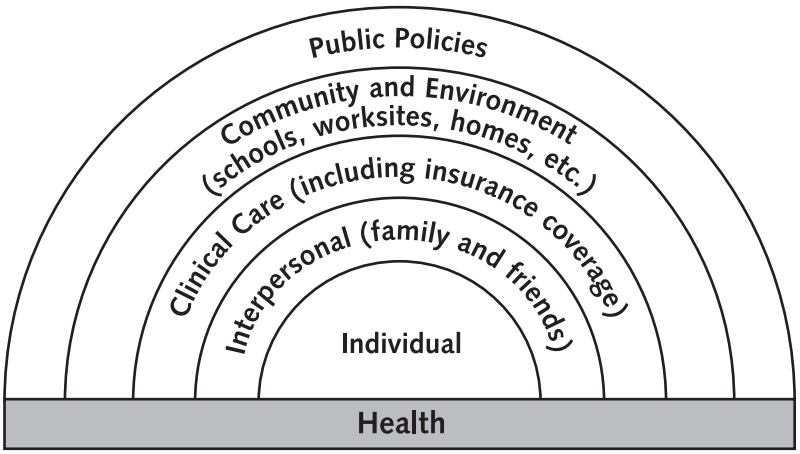
People do not act in a vacuum. Their actions are influenced not only by personal preferences, but by family, friends and peers; the advice they receive from their health providers; the broader community in which they live, attend school, or work; and public policies.

Each of the layers of the socio-ecologic model influences other levels. For example, an individual can influence his friends or family just as friends and families can influence the individual's behavior. Many individuals, working together, can influence public policies. And public policies can have a strong influence on the community and environment. As a result of this interconnectedness, interventions and strategies that address multiple levels are generally the most effective.[10]

North Carolina first began its multifaceted strategy to reduce tobacco use in 1991 with funding from the National Cancer Institute and the American Cancer Society, which was used to develop a tobacco prevention and reduction plan. The state implemented more systemic multifaceted interventions beginning in 2003, with the infusion of funding from the North Carolina Health and Wellness Trust Fund (HWTF). For example, the HWTF initiated a social marketing campaign (i.e. the TRU campaign) targeting individual behaviors and helped provide funding for QuitlineNC, which supports individuals who wanted to quit smoking. In addition

j The Task Force also recognized that personal behaviors and lifestyle choices do not contribute to all adverse health outcomes. For example, genetics plays a role in many illnesses. Exposure to environmental hazards may play a role in many cancers, and accidents may be caused by the actions of others rather than the individual who is harmed. The US Surgeon General estimated that as much as 50% of health outcomes are due to personal choices, 20% due to genetics, 20% due to environment or community factors, and 10% due to medical interventions.(Office of the Surgeon General, US Department of Health and Human Services. Healthy people: the Surgeon General's report on health promotion and disease prevention. http://profiles.nlm.nih.gov/NN/B/B/G/K/_/nnbbgk.pdf. Published 1979. Accessed July 15, 2009.)

Figure 2.4
Many Different Factors Influence Individual Behavior and Ultimately the Health of the Individual



Source: Figure created by the North Carolina Institute of Medicine.

to investments from the HWTF, North Carolina public and private insurers began to pay for clinical interventions (e.g. counseling and tobacco cessation medications); private funders (e.g. The Duke Endowment and HWTF) supported interventions to reduce tobacco use in the community (e.g. 100% tobacco-free schools and hospitals); and the North Carolina General Assembly supported policy interventions (e.g. increasing the tobacco tax, and later, mandating that all public schools be 100% tobacco-free). Prior to that, there was little improvement in tobacco use rates. Between 1995 and 2003, the adult smoking rate hovered at around 25%. Since implementing this multifaceted evidence-based strategy, the adult smoking rate decreased from 24.8% (2003) to 20.9% (2008). Similarly, the youth smoking rate has declined. From 2003 to 2007, the high school use rate declined from 27.3% to 19.0%, while the middle school use rate dropped from 9.3% to 4.5%. The implication from our state's improvement in tobacco use rates is clear: broad-based, systematic investment in multifaceted interventions can be effective at addressing seemingly "intractable" public health problems. The path demonstrated by our success in decreasing tobacco use should be replicated across the risk factors outlined in this report.

The Task Force learned from the success of our state's tobacco prevention activities; thus, when possible, the Task Force tried to identify evidence-based, best, or promising practices in different levels of the socio-ecological model. We can make progress in preventing and reducing other underlying causes of death and disability in North Carolina by adopting a similar approach that includes evidence-based strategies aimed at the various levels of the socio-ecologic model.

The implication from our state's improvement in tobacco use rates is clear: broad-based, systematic investment in multifaceted interventions can be effective at addressing seemingly "intractable" public health problems.

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