COUNTY HEALTH RANKINGS **WORKING PAPER**

DIFFERENT PERSPECTIVES FOR ASSIGNING WEIGHTS TO DETERMINANTS OF HEALTH

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Summary

The *County Health Rankings* are based on a model of population health including

- health outcomes--based on an equal weighting of length and quality of life, and
- health factors--weighted scores of four major factors: health behaviors, clinical care, social and economic factors, and the physical environment.

To calculate the health factors ranks in the *County Health Rankings,* each of the four components is weighted based on an assessment of its relative contribution to the health outcomes described above. Since there is no single *correct* weighting distribution, we arrived at weights drawing on a number of different perspectives:

A. Historical perspective
B. Review of the literature
C. Weighting schemes used by other health rankings
D. Analytic approach
E. Pragmatic (stakeholder engagement) approach

The following table summarizes the alternate weighting distributions suggested by these five perspectives and our recommended weighting scheme for the *County Health Rankings*:

Summary of Different Perspectives on Assigning Weights to Determinants of Health

	Historical Perspective	**Literature Review**	**Other Rankings***			**Analytic Approach**	**Pragmatic Approach**	***County Health Rankings***
			AHR	WI, KS, TN	NM			
Social and economic factors	Increasing importance ↑	21% (up to 8x clinical care)	27%	40%	40%	55%	25%	**40%**
Health behaviors		57%	37%	40%	40%	37%	25%	**30%**
Clinical care		14% (up to 50%)	27%	10%	15%	21%	25%	**20%**
Environmental factors		7%	9%	10%	5%	-3%	25%	**10%**

*AHR = America's Health Rankings; the four other rankings were done within the states of Wisconsin, Kansas, Tennessee, and New Mexico

DIFFERENT PERSPECTIVES
FOR ASSIGNING WEIGHTS TO DETERMINANTS OF HEALTH

Historical Perspective

Over the past century, the leading causes of death and morbidity in the United States have changed dramatically.

1930-1950: Sanitary revolution and improvements in environmental health

In the first half of the 20th century in the U.S., the leading causes of disease and death were associated with the unhealthy environments in which people lived. In 1900, pneumonia, influenza, tuberculosis, diarrhea, enteritis, and ulceration of the intestines accounted for nearly one-third of all deaths. These leading health problems resulted from poor sanitation (e.g., typhoid), unhealthy food supply (e.g., pellagra and goiter), poor prenatal and infant care, and unsafe workplaces or hazardous occupations (CDC 1999b). In response to these health problems, public health efforts focused on laws and regulations intended to improve the health of the environment, such as motor-vehicle safety regulations, occupational safety laws, and control of infectious diseases, safer and healthier foods, and fluoridation of drinking water (CDC 1999a). These policies led to dramatic reductions in communicable diseases and maternal and infant mortality.

1950-1970: Increasing role of health care

By the middle of the 20th century, heart disease and cancer had become the leading causes of death in the United States. The focus of interventions began to shift to health care services, including the delivery of "clinical preventive services" such as vaccination for childhood disease, improved maternal and prenatal care, and the detection and treatment of high blood pressure. Despite some attention to preventive services, most of the attention of the health care system focused on the treatment of diseases. Evans commented that "by midcentury the providers of health care had gained an extraordinary institutional and even more intellectual dominance, defining both what counted as health and how it was to be pursued." By the early 1970s, the U.S. had developed extensive and expensive systems of health care, underpinned by health insurance systems that covered most—but not all—children and adults (Evans and Stoddart 1990).

1970-1990: Contribution of health behaviors (smoking/diet/exercise) increases

As heart disease, cancer, stroke, and lung disease became the leading causes of death during the mid-1900s, public health researchers began to focus on identifying their causes. Large-scale studies such as the "Framingham Heart study", the "Seven Countries study", and the "British Doctors study" began to identify the leading causes of chronic diseases. These studies began to elucidate the important contributions of cigarette smoking, diet, physical inactivity, and high blood pressure to the leading causes of death.

The Lalonde Report was published in 1974 in Canada and has been recognized as the first modern government report to state that the emphasis on health care was not sufficient to improve the health of the population (Lalonde 1974). The report noted that the generally accepted view at that time was that the level of health in a population was equated with the level of "health care." Instead, it proposed a new "health field" concept that health be broken up into four broad elements: human biology, environment, lifestyle, and health care organization. The report emphasized individuals' roles in changing their behaviors to improve their health (Minkler 1989).

The publication of the now famous paper entitled "Actual Causes of Death" by McGinnis and Foege (1993) drew attention to the fact that many deaths were due to preventable causes, such as tobacco use, diet and activity patterns, and alcohol use. Later updated by Mokdad (2001), these studies concluded that approximately half of all deaths that occurred in 1990 could be attributed to the factors identified. Although no attempt was made to further quantify the impact of these factors on morbidity and quality of life, the public health burden they impose is considerable and offers guidance for shaping health policy priorities.

Expert opinion at the time suggested that health behaviors had the largest and most unambiguously measurable effect on health. Behaviors such as diet, exercise, substance abuse, were also factors most readily portrayed as under the control of individuals.

1990-present: Social and economic determinants

By the beginning of the 21st century, research had begun to focus farther "upstream" on those factors that increase the risk of not only diseases, but also the predisposing behavioral and other risk factors. According to the Institute of Medicine's report, *The Future of the Public's Health in the 21st Century*, "the greatest advances in understanding the factors that shape population health over the last two decades has been the identification of social and behavioral conditions that influence morbidity, mortality, and functioning" (Institute of Medicine 2002). Research has increasingly demonstrated the important contributions to health of factors beyond the physical environment, medical care, and health behaviors, e.g., socioeconomic position, race and ethnicity, social networks and social support, and work conditions, as well as economic inequality and social capital (Institute of Medicine 2002).

Research over the last 25 years has increasingly demonstrated the role of the "social determinants" of health such as income, education, occupation, and social cohesion as equal contributors to health outcomes. A seminal publication calling attention to the role of the social determinants was the book from the Canadian Institutes for Advanced research titled "Why Are Some People Health and Others Not? The Determinants of Health of Populations" (Evans, Barer,and Marmour, 1994). In this publication the Evans-Stoddart multiple determinant field model was advanced, as well as an early chapter explaining some of the neuroendocriine stress pathways through which the independent effects of the social determinats get "under the skin". Since that time, a new academic field of social epidemiology has developed (Berkman and Kawachi 2000), a highlight of which is the identification of the social gradient in health, in which it is not only the extremes of high and low levels of education and income which have health outcome effects but at most gradations in between.

One of the most important investigators in this field is Sir Michael Marmot, a British social epidemiologist, whose studies of British civil servants clearly illustrates the gradient effect of social and economic status on health (Marmot et al. 1978). The four administrative job categories reflect different education and income profiles among British civil servants. Marmot demonstrated there is increased mortality from heart disease at each of the four occupational levels (the "social gradient"). In addition, the contributions to this mortality from common risk factors such as blood pressure, smoking, and cholesterol, increase with lower occupational grade. Even so, the amount of mortality not explained by these standard risk factors, in a British system where all have access to medical care, is quite remarkable.

Such relationships have also been shown for income, education, and other components of the social determinants of health. While teasing apart the effects of these separate social factors is challenging for researchers, the evidence is convincing, for example, that level of education is probably as important as medical care and other factors in improving health. A large body of research supports this claim, including the fact that people in nations, states, and counties with higher education rates have better health outcomes in many categories. For example, in 2005, the age-adjusted mortality rate for adults with some education beyond high school was 206 per 100,000. However, it was twice as great for those with only a high school education, and three times as great for those with less than high school education (Department of Health and Human Services 2008). People with more education also have fewer disabilities and better physical functioning.

Review of the Literature

Unfortunately, although the literature has clearly established the individual importance of environmental, clinical care, health behaviors, and social and economic factors as determinants of health, there is no literature that specifically indicates the relative contribution of these four types of determinant to broad health outcomes, i.e., morbidity and mortality (how healthy people feel and how long they live).

An oft cited McGinnis et al (2002) paper states: "...using the best available estimates, the impacts of various domains on early deaths in the U.S. distribute roughly as follows: genetic predispositions, about 30%; social circumstances, 15%; environmental exposures, 5%; behavioral patterns, 40%; and shortfalls in medical care, 10%" (5). Since these estimates also include the contribution of genetic factors that are generally considered, at least for the moment, to be both non-modifiable and non-measurable, we need to adjust these estimates for use in determining weights for the *County Health Rankings*. Removing genetic factors, the revised estimates are:

Social circumstances	21%
Environmental exposures	7%
Behavioral patterns	57%
Medical care	14%

However, some caveats should be noted:

1) The "long standing estimate" of 10% for medical care is actually based on "expert" estimates of the contribution of health care system deficiencies to total mortality; (DHHS, 1980);
2) The estimates for medical care represent the contribution of medical care deficiencies to early deaths, rather than the positive contributions of medical care to avoiding mortality;
3) The estimates represent contributions to *early death* and do not address contributions to other important health outcomes, such as health-related quality of life; and
4) These estimates do not fully reflect the important interrelationships between the determinant categories.

Some investigators have examined single determinants of mortality; for example, Bunker estimated that 3 of the 7.5 years of life expectancy that were gained after 1950 were due to medical care (1994). Others attribute much of the gain (58%) in life-years to primary prevention or reductions in population risk factors such as smoking, cholesterol, and blood pressure (Unal et al., 2005). More recently, Cutler and others (2006) assigned a 50% weight to medical care, while also carrying out sensitivity analysis from 25% to 75%. Wilper et al. (2009) recently updated previous IOM figures, estimating that about 45,000 or 8% of deaths among 18-64 year olds were due to lack of health insurance.[1]

Wolff and colleagues (2007) have estimated that correcting disparities in education-associated mortality rates would have averted eight times more deaths than those attributable to medical advances between 1996 and 2002. One of the most precise studies, which controlled for many other possible explanations, showed a 1-3%reduction in mortality rates for each year of additional schooling (Elo and Preson 1996).

Looking at two determinant categories, using longitudinal data from the Americans' Changing Lives survey, Lantz and colleagues (2001) found that four common health risk behaviors (smoking, physical activity, alcohol consumption, and body mass index) had only modest impact in predicting functional status and self-rated health in low income populations after controlling for socioeconomic factors; they concluded that "risk behaviors are not the dominating mediating mechanism for socioeconomic health differences." Similar results had also been found using mortality as an outcome (Lantz et al 1998).

[1] Approximately 1 million deaths under age 75 occurred in 2000. Assuming no deaths in uninsured children and no uninsured 65-74 year olds, this means that lack of insurance accounted for a minimum 5% of premature deaths. One could assume that lack of insurance might have an equivalent impact on quality of life.

Weighting Schemes Used by Other Rankings

The other rankings efforts we examined all include measures of mortality *and* morbidity in their outcomes, but there are differences in:

a) How different categories of determinants are defined and
b) The specific measures used within each category of determinants.

The widely recognized *America's Health Rankings* (AHR) combines both outcomes and determinants in its weighting scheme: outcomes account for 25% and determinants 75% (6). We reassigned weights for the determinant categories in their 2009 report (see Appendix 1), to model the weights that would be given to each of their four determinants categories if determinants were weighted separately from outcomes:

- Behaviors 27%
- Community & environment 37%
- Public and health policies 17%
- Clinical care 20%.

Mapping the AHR measures to the specific measures to be included in the *County Health Rankings* yields the following distribution of weights:

Health behaviors (smoking, obesity, binge drinking)	37%
Clinical care (health insurance, primary care physicians, preventable hospitalizations)	27%
Social and economic factors (high school graduation, children in poverty, violent crime)	27%
Physical environment (air pollution)	9%

The University of Wisconsin Population Health Institute and two other public health institutes (Tennessee and Kansas) that have developed county health rankings based on Wisconsin's model have used the following overall weighting scheme for health factors:

Health behaviors	40%
Health care	10%
Socioeconomic factors	40%
Physical environment	10%

However, another state (New Mexico) that developed county health rankings based on the Wisconsin model made a slight modification to its weights:

Health behaviors	40%
Health care	**15%**
Socioeconomic factors	40%
Physical environment	**5%**

The Kentucky Institute of Medicine Task Force that oversaw the preparation of the *Health of Kentucky* report that included rankings of county health based on 25 health measures "decided that each measure would not be weighted and that each measure would be given equal value in the county total scores." The 25 measures are listed in Appendix 1. Nine of these measures reflect "health outcomes" and one measure was considered non-modifiable (population older than 65). The remaining measures did not include any environmental measures but the implicit weighting for the remaining measures can be inferred as follows:

- Behavioral/social factors (9 out of 15 measures) 60%
- Demographics (2 out of 15 measures) 13%
- Health access (4 out of 15 measures) 27%

Analytic Approach

Prior to acquiring the comprehensive national data now being used to compile the *County Health Rankings,* Athens (2008) set out to develop a model using county-level data to represent health outcomes and data reflecting three of the four health factors: health behaviors, health care, and social and economic factors (environmental factors were not readily available). Using a data set of about 400 of the more heavily populated counties in the U.S. and after verifying the validity of these three categories using factor analysis, Athens regressed measures representing the three categories sets on a health outcome score (premature death based on years of potential life lost prior to age 75 and self-reported health status). The resulting coefficients were converted to weights:

Determinant Category	Empirically Derived Weight
Social and economic factors	49%
Health behaviors	39%
Health care	12%

A recent similar analysis using the entire 2010 *County Health Rankings* dataset (including environmental factors) yielded the following results (for additional information see Appendix 2):

Determinant Category	Empirically Derived Weight
Health care	21%
Health behaviors	27%
Social and economic factors	55%
Physical environment	-3%

One of the issues in analysis such as these is the timing of determinants and outcomes. In the preceding analyses, our measures of determinants did not always precede our outcome measures. However, in another study where we conducted regression analysis, secondary county-level data were collected on *modifiable* and *nonmodifiable* health determinants from *1994-2000* for use as the independent variables, with mortality rates (under age 75 age-adjusted) from *2001-2003* as our dependent variable (Kindig et al, Public Health Reports in press*)*. While some time lag between determinants and outcomes was achieved, the lag was probably not long enough to fully capture the long term effects of determinants on outcomes. This regression analysis was then used to predict state age-adjusted mortality rates, where each state's "ideal" predicted mortality was determined based on the state achieving the best observed level among all states of modifiable determinants. The results of the regression analysis are shown in Appendix 3. As with all cross sectional analysis, a major limitation of the study was the use of ecologic data to derive associations which might indicate causal relationships. However, the model is conservative in that it is limited to the highest level of any modifiable variable that any state has already achieved; several such as high school graduation rates and smoking rates are likely to reach levels higher than any state has so far in the future.

Given the analytic limitations of the model, it is difficult to draw precise conclusions from the relative contributions of each modifiable determinant. The directions of the relationships are all in the expected directions based on theory and other empirical work. Of note however is the *larger independent association of the socioeconomic factors than the behavioral determinants*, which is consistent with previous work of Lantz and others cited earlier(Lantz et al 2001, Lantz et al 1998); this could be due in part to the greater reliability of socioeconomic variables from the census than the multiple years of BRFSS behavior survey data. The

magnitude of the living alone social determinant variable was surprising, although the direction of the association is consistent with previous work (Koskinen, 2007). Both this work and the studies of Lantz give credence to the likelihood that social determinants may make a greater contribution to many health outcomes than individual behaviors alone when their interrelationships are considered.

The preceding analysis focused solely on mortality but the World Health Organization has been periodically estimating the extent of risk factors for both death and quality of life (using the measure of disability-adjusted life years, or DALYs). Their most recent report (2009) provides further insights into the percentage of deaths and DALYs attributable to a variety of risk factors for the world, low-income, middle-income, and high-income countries (see Appendix 4). The 24 risk factors described in this report are responsible for 44% of global deaths and 34% of DALYs:

Childhood and maternal undernutrition: underweight, iron deficiency, Vitamin A deficiency, Zinc deficiency, suboptimal breastfeeding
Other diet-related risk factors and physical inactivity: high blood pressure, high cholesterol, high blood glucose, overweight and obesity, low fruit and vegetable intake, physical inactivity
Addictive substances: tobacco use, alcohol use, illicit drug use
Sexual and reproductive health: unsafe sex, unmet contraceptive need
Environmental risks: unsafe water, sanitation, hygiene; urban outdoor air pollution, indoor smoke from solid fuels, lead exposure, global climate change
Occupational risks: risk factors for injuries, carcinogens, airborne particulates, ergonomic stressors
Other risks: unsafe health-care injections, child sexual abuse

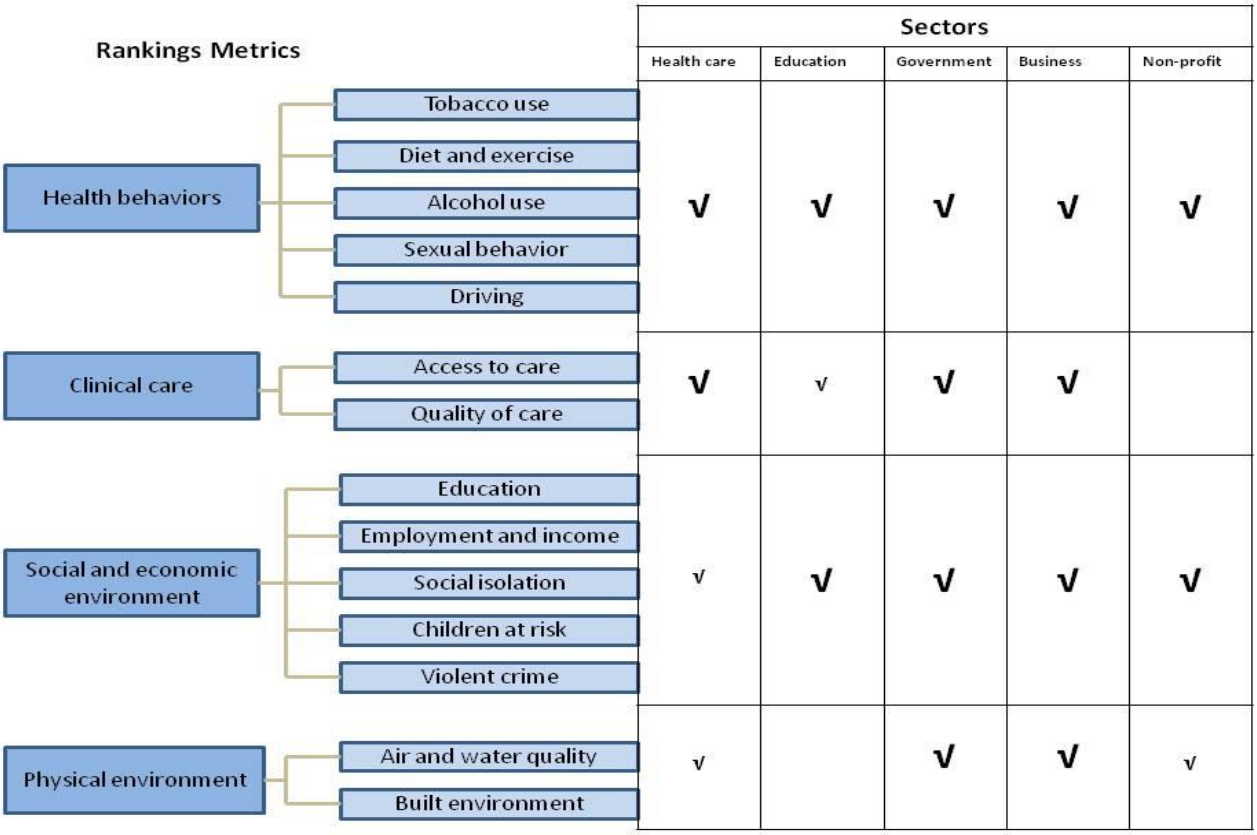
However, as seen from the list of risk factors examined, since the WHO report focused primarily on only two of the four main health factors in the *County Health Rankings:* health behaviors and the physical environment. Drawing on the results for high-income countries suggests the following attribution of cause that can assist us in determining relative weights within the behavioral and environmental health factors:

Deaths and DALYs attributed to selected risk factors in high-income countries, 2004	**Deaths**	**DALYs**
Diet-related risks and physical inactivity	25%	13%
Alcohol and drug use	2%	9%
Tobacco use	18%	11%
Environmental risks (urban outdoor air pollution, unsafe water/sanitation, and lead exposure)	3%	1%

Source: WHO. *Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks*. World Health Organization 2009, Geneva Switzerland.

Pragmatic Approach

The goal of the *County Health Rankings* is to engage multiple sectors in community health improvement. Some sectors are likely to be able to exert more influence on some health factors than others, as depicted in the graphic below. For example, the health care sector not only can influence measure of health care but can also make significant contributions in the area of health behaviors as well.



So, even though research may show that clinical care itself may have a smaller impact on health outcomes than health behaviors, the health care sector can influence health behaviors as well as clinical care. Thus, a more pragmatic approach to assigning weights that might encourage greater participation across multiple sectors in community health improvement might result if the four determinant categories were given equal weights, i.e.,

- 25% for health care
- 25% for behaviors
- 25% for social and economic factors, and
- 25% for physical environment.

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Appendix 1: Weighting in Other Rankings

America's Health Rankings

	Name of Measure	% of Total	Effect on Score
DETERMINANTS			
	Personal Behaviors		
	Prevalence of Smoking	7.5	Negative
	Prevalence of Binge Drinking	5.0	Negative
	Prevalence of Obesity	7.5	Negative
	Community & Environment		
	High School Graduation	5.0	Positive
	Violent Crime	5.0	Negative
	Occupational Fatalities	*2.5*	*Negative*
	Infectious Disease	*5.0*	*Negative*
	Children in Poverty	5.0	Negative
	Air Pollution	5.0	Negative
	Public & Health Policies		
	Lack of Health Insurance	5.0	Negative
	Public Health Funding	*2.5*	*Positive*
	Immunization Coverage	*5.0*	*Positive*
	Clinical Care		
	Adequacy of Prenatal Care	*5.0*	*Positive*
	Primary Care Physicians	5.0	Positive
	Preventable Hospitalizations	5.0	Negative
OUTCOMES			
	Poor Mental Health Days	*2.5*	*Negative*
	Poor Physical Health Days	*2.5*	*Negative*
	Geographic Disparity	*5.0*	*Negative*
	Infant Mortality	*5.0*	*Negative*
	Cardiovascular Deaths	*2.5*	*Negative*
	Cancer Deaths	*2.5*	*Negative*
	Premature Death	*5.0*	*Negative*
OVERALL HEALTH RANKING		100.0	

Note: *Italicized measures* were not included in analysis for determining weights of *County Health Rankings* determinants.

Behavioral/Social Factors
Prevalence of Smoking
Prevalence of Youth Smoking
Prevalence of Obesity
Lack of Physical Activity
Oral Health
Motor Vehicle Deaths
Violent Crime Offenses (per 100,000 population)
Drug Arrests (per 100,000 population)
Occupational Fatalities (per 100,000 workers)

Demographics
High School Graduation
Per Capita Personal Income
Population Older Than 65

Health Access
Uninsured Population
Primary Care Physician to Population Ratio (HPSA 1:3,500)
Adequacy of Prenatal Care
Immunization Coverage

Health Outcomes
Low Birthweight Infants (percent of 1,000 live births)
Infant Mortality (deaths per 1,000 live births)
Infectious Disease (cases per 100,000 population)
Prevalence of Diabetes (percent adults)
Limited Activity Days
Cardiovascular Deaths (per 100,000 population)
Cancer Deaths (per 100,000 population)
Total Mortality (per 100,000 population)
Premature Death (YPLL-75 deaths per 100,000 population)

Note: *Italicized measures* were not included in analysis for determining weights of *County Health Rankings* determinants.

Appendix 2: Analysis of 2010 County Health Rankings Dataset

We used multivariate linear regression models to determine the relationship between our measure of county health outcomes, based on an equal weighting of length and quality of life, and health determinant measures in four categories: clinical care, health behaviors, social and economic factors, and physical environment. The specific construction of the health outcomes score was based on the following weighting: premature death, 50%; self-reported health status, 10%, average number of physically unhealthy days per month, 10%; average number of mentally unhealthy days per month, 10%, and percent of low birthweight live births, 20%.

We ran six models:

Model 1: All the individual indicators were regressed on the outcome z-score. This approach demonstrates whether each indicator is significantly associated with the outcome variables. Using composite scores for the categories of health factors masks the independent contribution of the indicators on change in health outcomes.

Model 2: The health factors were regressed on the outcome score. The goal of this model was to develop a weighting scheme for the categories of health factors in their relationship to the health outcomes score. (Each of the measures within a health factor category was weighted equally.)

Models 3-6: We regressed the measures in each of the four determinant categories, to determine the relative contribution to health outcomes of the measures within each category, relative only to other measures within the same category.

Before running the regression analyses, we converted all measures—outcomes and determinants-to z-scores. Because z-scores are unit-less, they facilitate analysis when using a wide array of measures and allow for the creation of composite variables (Allen and Sharpe 2005); the disadvantage is that the coefficients are more difficult to interpret. It is also important to note that because the data are ecologic and cross-sectional, it is impossible to prove that changes in the health factors in the model actually effect change in health outcomes. The purpose of this analysis was not establish causality but to identify potential relative contributions of different health factors to the health outcome score upon which the *County Health Rankings* are based.

The results for Models 1 and 2 follow. Because of missing data for many measures, the sample size for Model 1 was reduced from the total number of 3141 counties to 1265 counties where data were available for every indicator. For Model 2, the sample size was larger since its construction did not require that data be available for every measure.

REGRESSION MODELS (dependent variable: health outcomes score)

			MODEL 1			
		Variable	UNSTD B	SE	STD B	Pr > |t|
	Expected Effect	Intercept	0.01	0.01	0.00	0.26
CLINICAL						
CARE	+	% Unisured	-0.06	0.01	-0.06	<.0001
	-	General Practice MDs/100K Pop	-0.03	0.01	-0.03	0.01
	-	% Diabetic Medicare Enrollees Rcv HbA1c Test	-0.03	0.01	-0.03	0.01
	+	Discharge rate for Ambulatory Care-Sensitive Conditions	0.11	0.01	0.11	<.0001
	-	% Chronically Ill Patients Admitted to Hospice in Last 6 Mo. Life	0.00	0.01	0.01	0.61
HEALTH						
BEHAVIORS	+	Adult Smoking Prevalence	0.18	0.01	0.22	<.0001
	+	Obesity (BMI>=30) Prevalence	0.01	0.01	0.01	0.30
	+	Binge Drinking Prevalence	-0.14	0.01	-0.18	<.0001
	+	Chlamydia Rate per 100K	0.09	0.02	0.09	<.0001
	+	Teen Birth Rate, Ages 15-19/1K	0.05	0.02	0.07	0.00
	+	Crude Motor Vehicle-Related Mortality Rate/100K	0.21	0.02	0.21	<.0001
SOCIAL AND						
ECONOMIC	-	Average high school freshman graduation rate	-0.07	0.01	-0.08	<.0001
FACTORS	-	% Adults 35+ who graduated college	-0.01	0.02	-0.01	0.66
	+	Unemployment rate	-0.02	0.01	-0.02	0.20
	+	% Children in poverty	0.18	0.02	0.21	<.0001
	+	Gini Coefficient	0.08	0.01	0.10	<.0001
	+	Prevalence of Not Getting Social/Emotional Support	0.05	0.01	0.07	<.0001
	+	% Single-parent households	0.02	0.02	0.02	0.19
	+	Violent Crime Rate/100K	0.04	0.01	0.07	<.0001
PHYSICAL						
ENVIRONMENT	+	Unhealthy Air Quality Days - PM2.5	0.01	0.01	0.02	0.19
	+	Unhealthy Air Quality Days - Ozone	0.01	0.01	0.02	0.19
	+	% Zipcodes in County w/out Healthy Food Outlet	0.01	0.01	0.01	0.35
	+	Liquor Stores per 10K population	-0.02	0.01	-0.02	0.08
MODEL		N	1,265			
FITS		ADJ RSQ	0.85			
		F VALUE	302.70			

		P	<.0001			
			MODEL 1			
		Variable	UNSTD B	SE	STD B	Pr > |t|
	Expected Effect	Intercept	0.01	0.01	0.00	0.97
CLINICAL			0.06	0.00	0.19	<.0001
CARE	+	% Unisured				
	-	General Practice MDs/100K Pop				
	-	% Diabetic Medicare Enrollees Rcv HbA1c Test				
	+	Discharge rate for Ambulatory Care-Sensitive Conditions				
	-	% Chronically Ill Patients Admitted to Hospice in Last 6 Mo. Life				
HEALTH			0.07	0.00	0.25	<.0001
BEHAVIORS	+	Adult Smoking Prevalence				
	+	Obesity (BMI>=30) Prevalence				
	+	Binge Drinking Prevalence				
	+	Chlamydia Rate per 100K				
	+	Teen Birth Rate, Ages 15-19/1K				
	+	Crude Motor Vehicle-Related Mortality Rate/100K				
SOCIAL AND			0.08	0.00	0.51	<.0001
ECONOMIC	-	Average high school freshman graduation rate				
FACTORS	-	% Adults 35+ who graduated college				
	+	Unemployment rate				
	+	% Children in poverty				
	+	Gini Coefficient				
	+	Prevalence of Not Getting Social/Emotional Support				
	+	% Single-parent households				
	+	Violent Crime Rate/100K				
PHYSICAL			-0.01	0.00	-0.03	0.00
ENVIRONMENT	+	Unhealthy Air Quality Days - PM2.5				
	+	Unhealthy Air Quality Days - Ozone				
	+	% Zipcodes in County w/out Healthy Food Outlet				
	+	Liquor Stores per 10K population				
MODEL		N	3,093			
FITS		ADJ RSQ	0.66			
		F VALUE	1481.25			
		P	<.0001			

Appendix 3: Results from Kindig et al (in press)

Table 1 shows the results of Kindig et al's analysis. The final ecologic model predicting counties' mortality rates (n=3,017 counties) had an R^2 value of 0.87, indicating a very high level of prediction of county mortality with the 25 retained first- and second-order (squared) terms. The second-to-last column shows the change in the number of deaths of those younger than 75 years of age per 100,000 population for a 1% prevalence increase of each predictor variable (or $1,000 increase in median household income). Note that the prevalences had varying ranges (comparing states' minimum and maximum prevalences among variables), so that a 1% increment for employment rate (range: 3.6% to 6.1%) was relatively more pronounced than a 1% increment in prevalence of college graduates (range: 15% to 30%).

Table 1. Study results: Regression analysis of modifiable and nonmodifiable variables on county deaths per 100,000 population (2001-2003)

	States' mean (% or $)	States' min. (% or $)	States' max. (% or $)	Main-effect co-efficient (deaths per 100,000)	Squared term co-efficient (deaths per 100,000)	Estimated increment (or decrement) of deaths per 100,000 for a 1% increased prevalence*	P-value†
Intercept				131			
Nonmodifiable Variables							
% native-born	91.8	72.7	98.6	3.9		3.9	<.0001
% rural	28.3	5.5	61.8	-0.64		-0.64	<.0001
Race %							
African American	10.4	0.5	36.6	1.8		1.8	<.0001
Asian	3.7	0.7	58.1	1.2		1.2	<.0001
Pacific Islander	0.7	0.0	23.3	-2.2		-2.2	<.0001
American Indian	2.4	0.4	19.1	1.4		1.4	<.0001
% age 65 and over	12.5	5.7	17.6	-2.1		-2.1	<.0001
% female	50.8	48.3	51.9	2.0		2.0	0.001
% Hispanic or Latino	7.8	0.7	42.1	0.099	-0.012	0.003	<.0001
Modifiable Variables							
% uninsured	13.4	**8.2**	23.7	11.3	-0.26	7.8	<.0001
% high school graduates	81.9	72.8	**88.1**	-3.9		-3.9	<.0001
Median family income ($1000)	50.0	37.0	**66.3**	-3.6	0.033	-1.9	<.0001
% college graduates	23.8	15.0	**33.1**	-2.7		-2.7	<.0001
% living alone	9.8	**5.6**	11.7	7.2		7.2	<.0001
% inactive	56.6	**47.1**	67.9	2.3	-0.019	1.3	0.001
% smokers	23.1	**13.9**	30.0	1.7		1.7	<.0001
% unemployed	3.6	**2.5**	6.1	0.72	0.36	2.0	<.0001

% obese	18.1	**13.0**	23.0	0.49	0.49	0.003

Appendix 4: Results from World Health Organization

Table 2: Ranking of selected risk factors: 10 leading risk factor causes of DALYs by income group, 2004

	Risk factor	DALYs (millions)	Percentage of total		Risk factor	DALYs (millions)	Percentage of total
	World				***Low-income countries[a]***		
1	Childhood underweight	91	5.9	1	Childhood underweight	82	9.9
2	Unsafe sex	70	4.6	2	Unsafe water, sanitation, hygiene	53	6.3
3	Alcohol use	69	4.5	3	Unsafe sex	52	6.2
4	Unsafe water, sanitation, hygiene	64	4.2	4	Suboptimal breastfeeding	34	4.1
5	High blood pressure	57	3.7	5	Indoor smoke from solid fuels	33	4.0
6	Tobacco use	57	3.7	6	Vitamin A deficiency	20	2.4
7	Suboptimal breastfeeding	44	2.9	7	High blood pressure	18	2.2
8	High blood glucose	41	2.7	8	Alcohol use	18	2.1
9	Indoor smoke from solid fuels	41	2.7	9	High blood glucose	16	1.9
10	Overweight and obesity	36	2.3	10	Zinc deficiency	14	1.7
	Middle-income countries[a]				***High-income countries[a]***		
1	Alcohol use	44	7.6	1	Tobacco use	13	10.7
2	High blood pressure	31	5.4	2	Alcohol use	8	6.7
3	Tobacco use	31	5.4	3	Overweight and obesity	8	6.5
4	Overweight and obesity	21	3.6	4	High blood pressure	7	6.1
5	High blood glucose	20	3.4	5	High blood glucose	6	4.9
6	Unsafe sex	17	3.0	6	Physical inactivity	5	4.1
7	Physical inactivity	16	2.7	7	High cholesterol	4	3.4
8	High cholesterol	14	2.5	8	Illicit drugs	3	2.1
9	Occupational risks	14	2.3	9	Occupational risks	2	1.5
10	Unsafe water, sanitation, hygiene	11	2.0	10	Low fruit and vegetable intake	2	1.3

[a] Countries grouped by 2004 gross national income per capita – low income (US$ 825 or less), high income (US$ 10 066 or more).

Table 4: Deaths and DALYs attributable to six diet-related risks and physical inactivity, and to all six risks combined, by region, 2004

Risk	World	Low and middle income	High income
Percentage of deaths			
High blood pressure	12.8	12.1	16.8
High blood glucose	5.8	5.6	7.0
Physical inactivity	5.5	5.1	7.7
Overweight and obesity	4.8	4.2	8.4
High cholesterol	4.5	4.3	5.8
Low fruit and vegetable intake	2.9	2.9	2.5
All six risks	**19.1**	**18.1**	**25.2**
Percentage of DALYs			
High blood pressure	3.8	3.5	6.1
High blood glucose	2.7	2.5	4.9
Physical inactivity	2.1	1.9	4.1
Overweight and obesity	2.4	2.0	6.5
High cholesterol	2.0	1.8	3.4
Low fruit and vegetable intake	1.1	1.0	1.3
All six risks	**7.0**	**6.5**	**12.6**

Table 5: Deaths and DALYs attributable to alcohol, tobacco and illicit drug use, and to all three risks together, by region, 2004

Risk	World	Low and middle income	High income
Percentage of deaths			
Alcohol use	3.6	4.0	1.6
Illicit drugs	0.4	0.4	0.4
Tobacco use	8.7	7.2	17.9
All three risks	**12.6**	**11.5**	**19.6**
Percentage of DALYs			
Alcohol use	4.4	4.2	6.7
Illicit drugs	0.9	0.8	2.1
Tobacco use	3.7	3.1	10.7
All three risks	**9.0**	**8.1**	**19.2**

Table 6: Deaths and DALYs attributable to five environmental risks, and to all five risks combined by region, 2004.

Risk	World	Low and middle income	High income
Percentage of deaths			
Indoor smoke from solid fuels	3.3	3.9	0.0
Unsafe water, sanitation, hygiene	3.2	3.8	0.1
Urban outdoor air pollution	1.7	1.7	2.1
Global climate change	0.2	0.3	0.0
Lead exposure	0.2	0.3	0.0
All five risks	**9.3**	**10.3**	**2.6**
Percentage of DALYs			
Indoor smoke from solid fuels	2.7	2.9	0.0
Unsafe water, sanitation, hygiene	4.2	4.6	0.3
Urban outdoor air pollution	0.5	0.5	0.8
Global climate change	0.4	0.4	0.0
Lead exposure	0.6	0.6	0.1
All five risks	**8.8**	**9.4**	**1.2**

WHO. Global health risks: mortality and burden of disease attributable to selected major risks. **© World Health Organization 2009, Geneva Switzerland. Accessed November 2, 2009 at http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf**