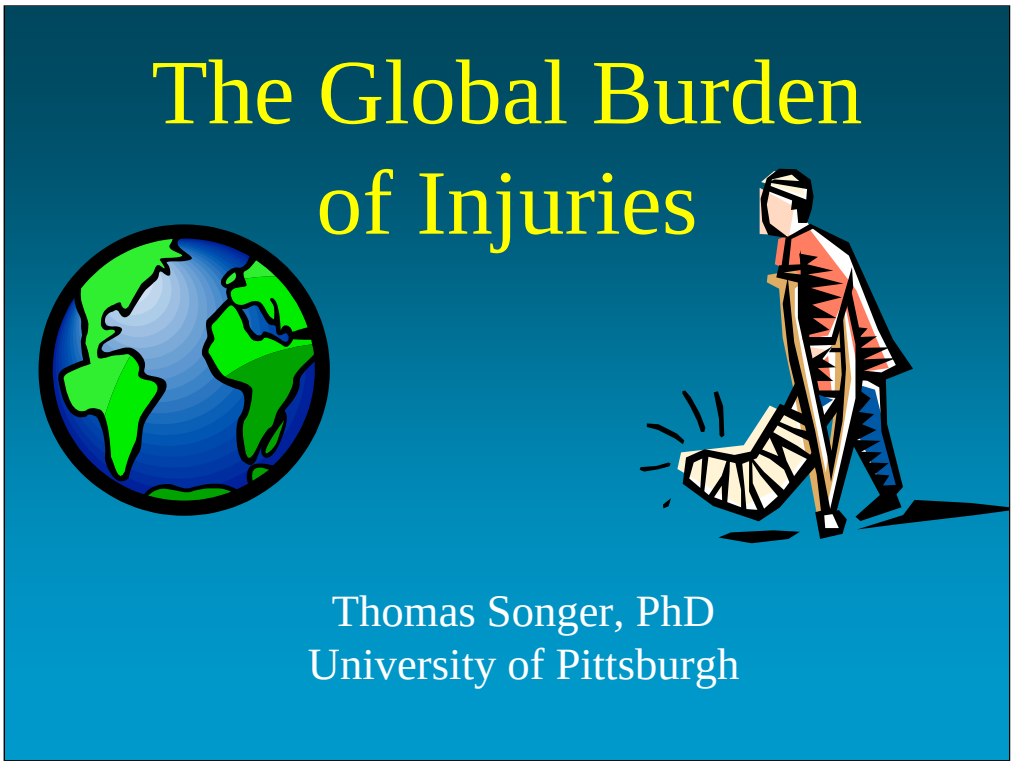


This lecture outlines the importance of injuries in a global context. Upon completing the lecture, the reader should be able to:

1. Describe the leading causes of mortality and morbidity and describe how injuries compare with these conditions

2. Describe the burden of injuries among different population sub-groups

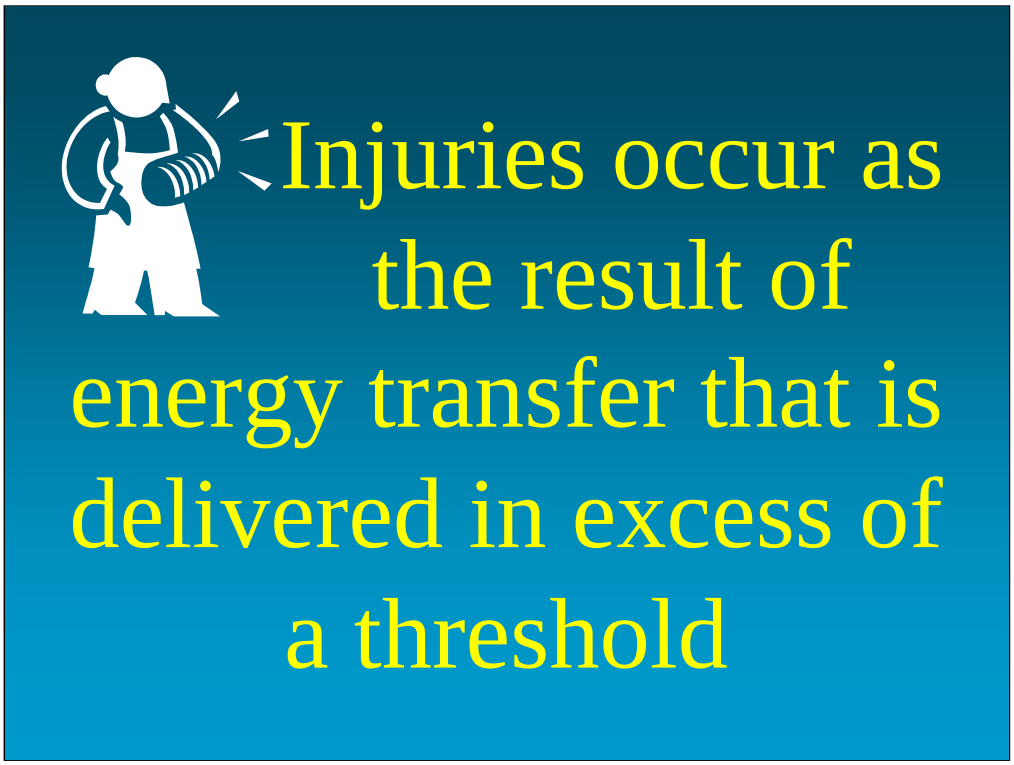
3. Describe the limitations which may affect our understanding of the burden of injuries

Further Reading: Krug EG, Sharma GK, Lozano R. The Global Burden of Injuries. American Journal of Public Health 90(4):523-26, 2000.

To begin to understand injuries and their impact, is is important to start with a working definition of what injuries are.

Think, for a brief moment, of how you would answer this question, “What are Injuries?”

This question can be answered in many different ways.



The fundamental philosophy in injury research is to define injuries with respect to energy transfer. Injuries occur when humans are exposed to energy forces that are larger than the body's normal tolerance levels for energy absorption. In other words, if an individual encounters a situation where an impact with an object occurs, an injury will result if the level of energy transfer encountered exceeds the body's threshold to withstand the energy force. Injuries can result from several different forms of abnormal energy transfer, including mechanical, chemical, electrical, and radiant energy. In some situations, such as drowning and strangulation, the injury results from an insufficiency of a vital element (Krug 2000).

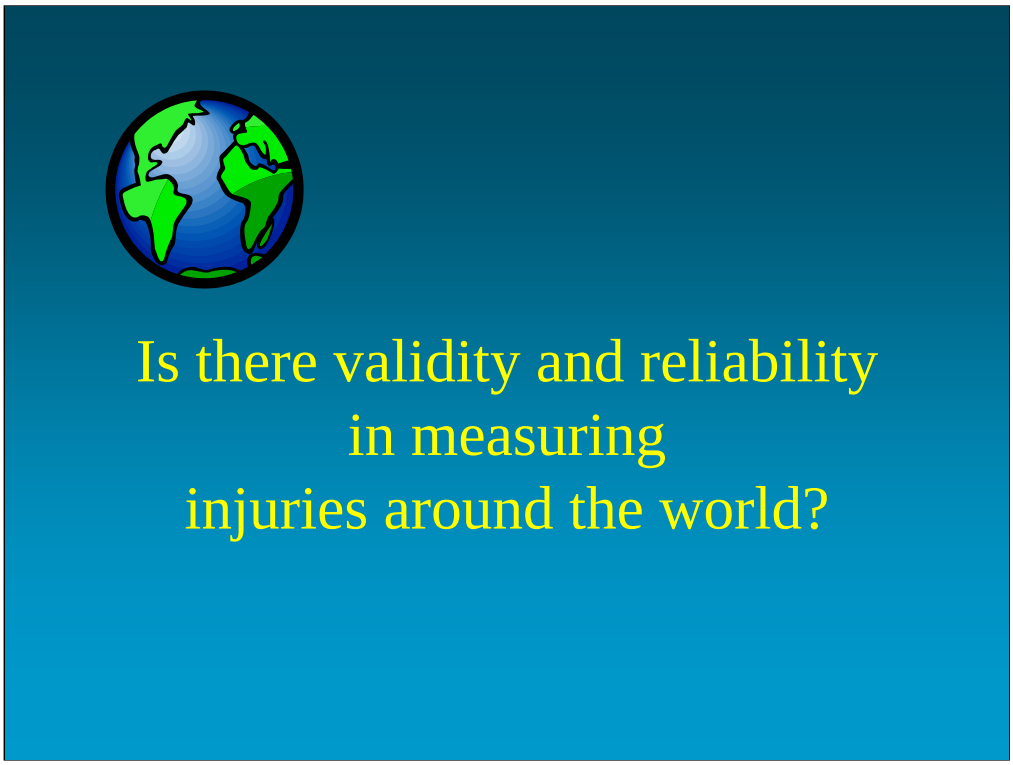
Injuries, though, are often defined by the methods in which they are measured. As we will see in the next slide, injuries are measured in multiple ways.

Documents used to Record Injuries

- Death certificates
- Medical records
- Work records
- coroner's reports
- police reports
- crash reports
- registry forms

Injuries can be assessed in multiple settings, including medical, occupational, criminal justice, transportation, and administrative settings. This slide lists the major types of documents that can contain injury information in these settings. It is important to point out that the definition of injury may differ between these sources and documents. While many individuals will characterize injuries from a medical treatment standpoint, the types of injuries identified in these sources can differ in severity, mechanism, and frequency of recording.

While many sources of injury information exist to characterize their frequency of occurrence, the best information often only pertains to particular settings. Constructing a measure of the overall burden of injuries to society has proven to be a rather difficult task to accomplish.

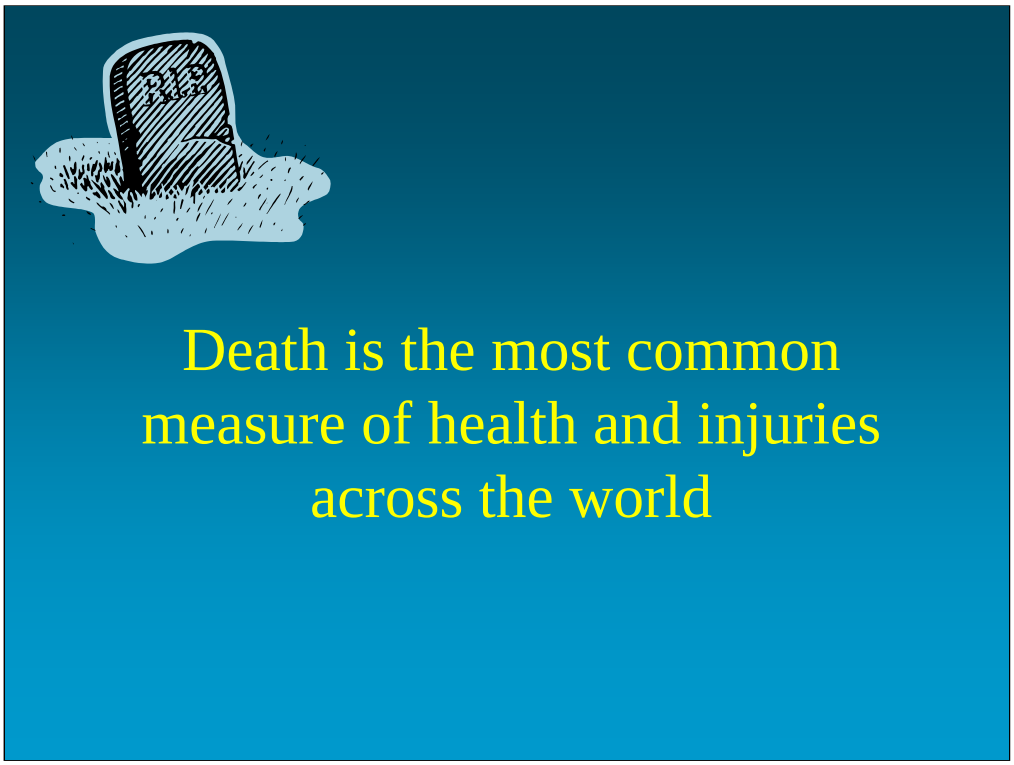


Building a measure of burden that allows for comparisons across countries is even more tricky. Consider, first, the issue of validity and reliability in the measurement of injuries. Do you think that injuries are measured in the same way around the world?

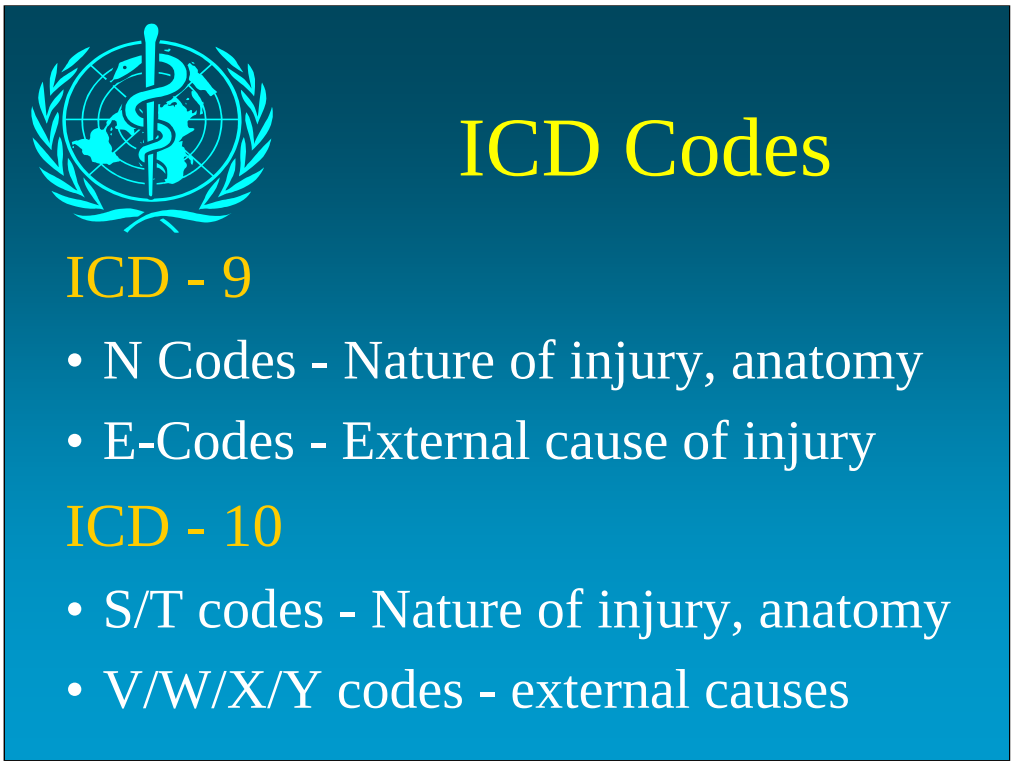
To answer the question about validity and reliability, consider that the definition of perception of injury can differ around the world. This slide illustrates common words that are used to describe events that may involve an injury. In some instances, these words are actually used to refer to injuries. Thus, one of the difficulties in comparing injuries in a global context is the lack of a standard terminology to refer to injuries.

Now, let's jump deeper into the issue and think about situations where common sources of injury information may exist between countries. For example, consider injuries that are treated in hospital. What are the validity and reliability issues in this context?

Just because injuries are measured in the same setting (hospital) does not ensure that the information is comparable between countries. First, the types of patients that are treated in the hospitals may differ. One hospital may have a trauma center while another may not. Second, the manner in which injuries are recorded may differ. One hospital may have a coding mechanism to identify injuries, while another may only identify injuries through narrative text. Third, the recording of injuries that deal with sensitive subjects, such as rape, sexual assault, and suicide) may differ by institution. This may be affected by administrative rules or by cultural sensitivities.



In looking to construct a global measure of burden, one of the first domains that is examined is mortality. This is because deaths are the most common form of health measurement in the world. The establishment of a standard, in terms of recording the details of all deaths in a death certificate, is the primary reason for this finding.



An additional standard applies in that nearly all deaths in the world are categorized by the International Classification of Diseases (ICD) system and codes.

Presently, you may encounter injury data that utilizes two versions of the ICD system, Version 9 and Version 10.

Version 9 includes two types of ICD codes are of most interest for injury research; N-codes (nature of injury codes) which identify the anatomy involved in the injury, and E-codes (external cause of injury codes) which identify the events leading to the injury.

Identifying injuries in Version 10 is a bit different. S and T codes characterize the nature of injury. External Cause of Injury related categories of interest include V, W, X, and Y codes.

At present, Version 10 is currently in use, worldwide, for mortality statistics. Version ICD 9-CM is still widely used for non-fatal events. Version ICD 10-CM is now being used for classifying non-fatal injuries in some countries.

ICD Codes and Injuries

Injury	ICD-9	ICD-10
Road Traffic Injury	E810-919	V02-04, V09, V12-14, V19, V20-79, V86-89
Poisoning	E850-869	X40-X49
Falls	E880-888	W00-W19
Fires	E890-899	X00-X09
Drowning	E910	W65-W74
Firearm accidents	E922	W32-W34
Self-inflicted injury	E950-959	X60-X84
Homicide/assault	E960-969	X85-Y09
War	E990-999	Y35-Y36

This slide illustrates how similar types of injuries are coded in the ICD-9 and ICD-10 classification systems.

Framework for Presenting Injury Mortality Data

Mechanism/ Cause	Manner/Intent			
	Unintentional	Intentional		
		Homicide	Suicide	etc.
Fall				
Firearm				
MVA				
Poison				

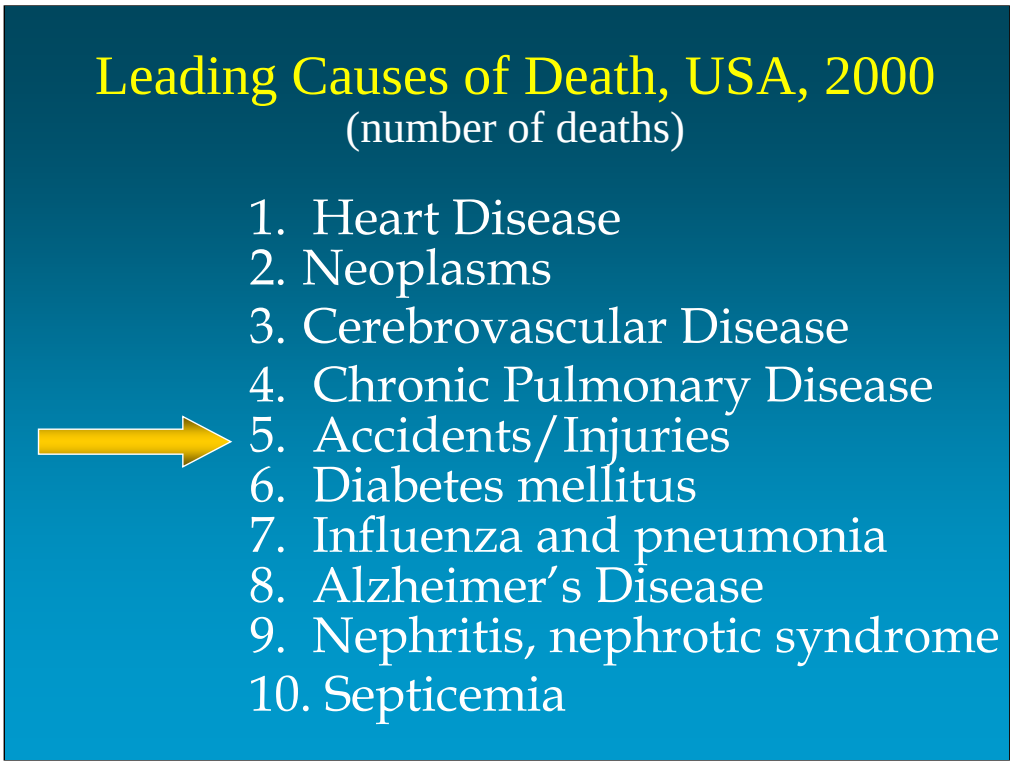
Another standard for examining injuries is the framework for looking at and presenting injury mortality statistics. The International Collaborative Effort (ICE) on Injury Statistics led this effort to seek to standardize the format in which injury mortality statistics are presented. Until this effort, injury mortality was presented in various different formats. This led to problems in trying to compare data across and within countries.

The fundamental elements of the framework include the manner and mechanism of the injury. The manner of injury is categorized here (and throughout injury research) as unintentional or intentional in basis. Motor vehicle related injuries are an example of unintentional injuries. There is no intent underlying this form of injury. Violence-related injuries are examples of intentional injuries. Homicide and suicide are injury deaths that involve a level of intent.

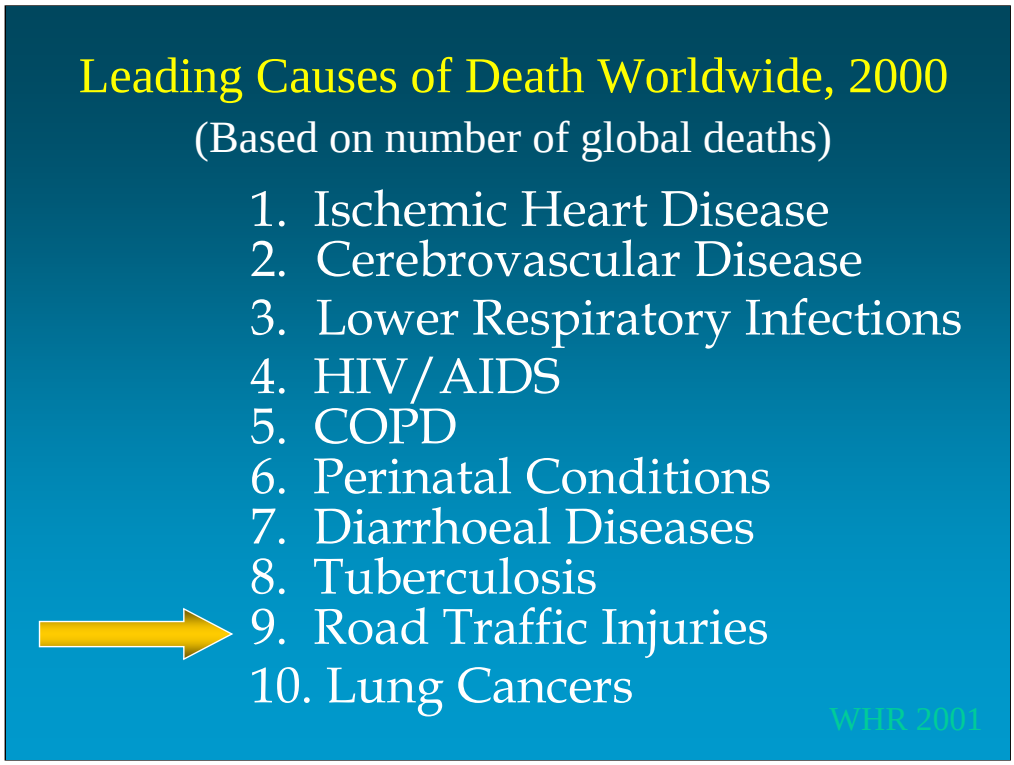
The mechanism or cause of injury is the second aspect of this framework. In the ICE initiative, cause of injury categories have been standardized based upon ICD codes. They include fall, firearm, motor vehicle, and other causes.

More information on the ICE is available at:

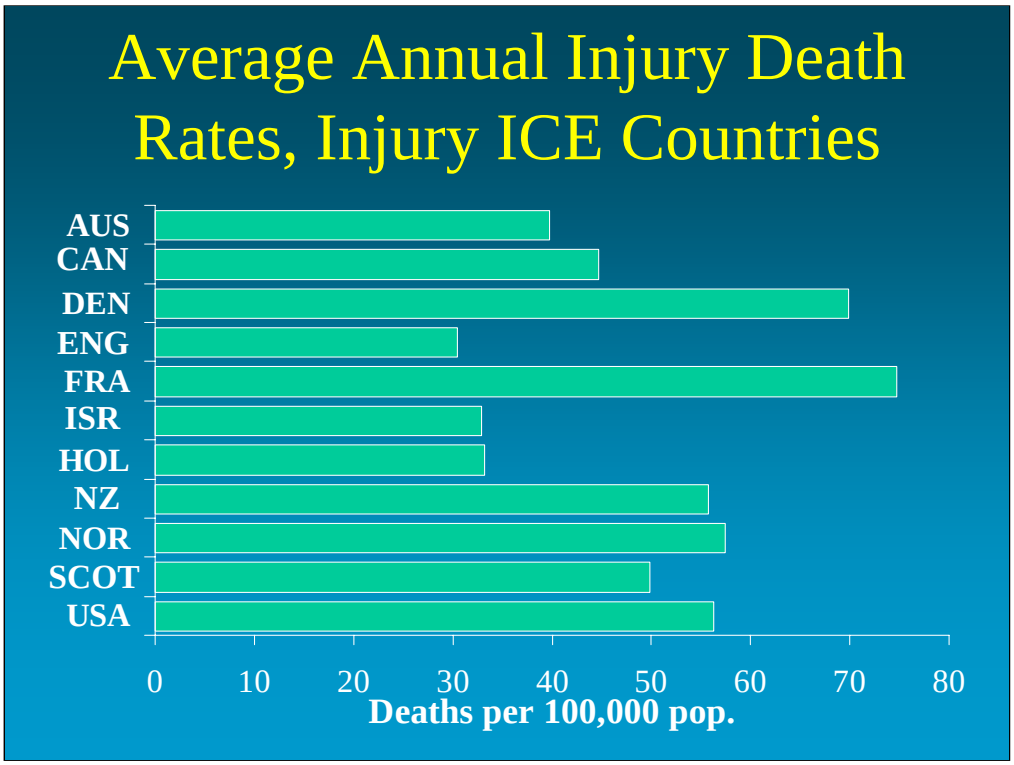
http://www.cdc.gov/nchs/advice.htm



The burden of disease as characterized by mortality data in the United States is shown in this slide. Using death certificate information, the leading causes of death can be compiled and ranked. In the United States, heart disease and cancer are the first and second ranked conditions listed on death certificates as the underlying cause of death. Injuries are represented as the fifth leading cause of death. Note that the definition of burden here is the number of deaths occurring in the year 2000.



Globally, we see a slightly different picture with respect to the burden of disease characterized by mortality statistics. Heart disease and stroke are both highly ranked as the leading causes of death. However, HIV/AIDs and major childhood diseases are evident in this global league table. Injuries are ranked as the 9th leading cause of death worldwide.



When comparing injury deaths between countries, we see in this graphic illustrates that differences exist in the burden of injuries by country. Note the definition applied in this situation is injury death rate. This is equivalent to the number of injury deaths divided by the population of the country. The use of injury death rates allows for better comparison between countries.

As noted in the slide, marked difference exist for the frequency of injury death in the developed countries listed. England, Holland and Israel have the lowest injury death rates, while Denmark and France have the highest death rates. These data pertain to the year 1996. Injury death rates may have changed somewhat in these countries since that time.

10 Leading Causes of Deaths by Age Group - 1995

	Age Groups										
Rank	<1	1-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65+	Total
1	Congenital Anomalies 6,554	Unintentional Injuries 2,280	Unintentional Injuries 1,612	Unintentional Injuries 1,932	Unintentional Injuries 13,842	Unintentional Injuries 13,435	HIV 18,860	Malignant Neoplasms 44,186	Malignant Neoplasms 87,898	Heart Disease 615,426	Heart Disease 737,563
2	Short Gestation 3,933	Congenital Anomalies 695	Malignant Neoplasms 523	Malignant Neoplasms 503	Homicide 7,284	HIV 11,894	Malignant Neoplasms 17,110	Heart Disease 34,498	Heart Disease 68,240	Malignant Neoplasms 381,142	Malignant Neoplasms 538,455
3	SIDS 3,397	Malignant Neoplasms 488	Congenital Anomalies 242	Homicide 405	Suicide 4,784	Suicide 6,292	Unintentional Injuries 14,225	Unintentional Injuries 9,261	Bronchitis Emphysema Asthma 9,988	Cerebro-vascular 138,762	Cerebro-vascular 157,991
4	Respiratory Distress Synd. 1,454	Homicide 452	Homicide 157	Suicide 330	Malignant Neoplasms 1,642	Homicide 6,162	Heart Disease 13,603	HIV 8,179	Cerebro-vascular 9,735	Bronchitis Emphysema Asthma 88,478	Bronchitis Emphysema Asthma 102,899
5	Maternal Complications 1,309	Heart Disease 251	Heart Disease 130	Congenital Anomalies 207	Heart Disease 1,039	Malignant Neoplasms 4,875	Suicide 6,467	Cerebro-vascular 5,473	Diabetes 8,188	Pneumonia & Influenza 74,297	Unintentional Injuries 93,320
6	Placenta Cord Membranes 962	HIV 210	HIV 123	Heart Disease 164	HIV 629	Heart Disease 3,461	Homicide 4,118	Liver Disease 5,247	Unintentional Injuries 6,743	Diabetes 44,452	Pneumonia & Influenza 82,923
7	Perinatal Infections 788	Pneumonia & Influenza 156	Pneumonia & Influenza 73	Bronchitis Emphysema Asthma 105	Congenital Anomalies 452	Cerebro-vascular 720	Liver Disease 3,705	Suicide 4,532	Liver Disease 5,356	Unintentional Injuries 29,099	Diabetes 59,254
8	Unintentional Injuries 787	Perinatal Period 87	Benign Neoplasms 50	HIV 66	Bronchitis Emphysema Asthma 246	Pneumonia & Influenza 622	Cerebro-vascular 2,772	Diabetes 3,996	Pneumonia & Influenza 3,458	Alzheimer's Disease 20,230	HIV 43,115
9	Pneumonia & Influenza 492	Septicemia 80	Bronchitis Emphysema Asthma 38	Benign Neoplasms 55	Pneumonia & Influenza 207	Diabetes 614	Diabetes 1,844	Bronchitis Emphysema Asthma 2,756	Suicide 2,804	Nephritis 20,182	Suicide 31,284
10	Intrauterine Hypoxia 475	Cerebro-vascular 57	Anemias 31	Pneumonia & Influenza 55	Cerebro-vascular 172	Liver Disease 604	Pneumonia & Influenza 1,480	Pneumonia & Influenza 2,079	HIV 2,320	Septicemia 16,899	Liver Disease 25,222

SOURCE: United States, NCIPC, 1998.

The impact of injury may differ by other forms of categorization as well. This slide depicts the leading causes of death by age group. Unintentional injury deaths are noted by the blue squares. Homicide deaths are noted by the red squares, and suicide deaths are noted by the green squares.

The table shows that these injury categories are the leading causes of death for persons aged 1-34 years. Unintentional injuries are ranked as the leading cause of death. Homicide is the 2nd leading cause of death for persons aged 15-24 years. Suicide is the 3rd leading cause of death for persons aged 15-34.

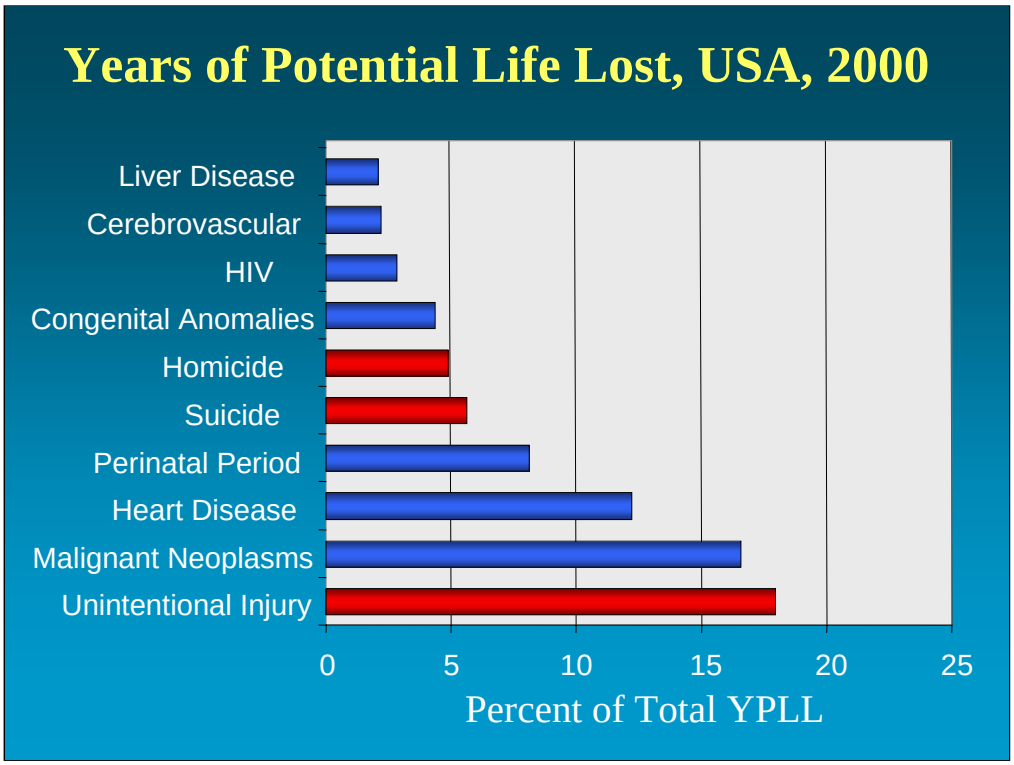
Though injuries are ranked highest in the young, they remain important at other age groups as well.

Years of Potential Life Lost

- Premature mortality is measured by the Years of Potential Life Lost (YPLL) statistic. For the purpose of calculating YPLL, premature death is defined as death occurring before the age of 65.
- YPLL are calculated using death certificate data.
- To calculate YPLL, the person's age at death is subtracted from 64.5.

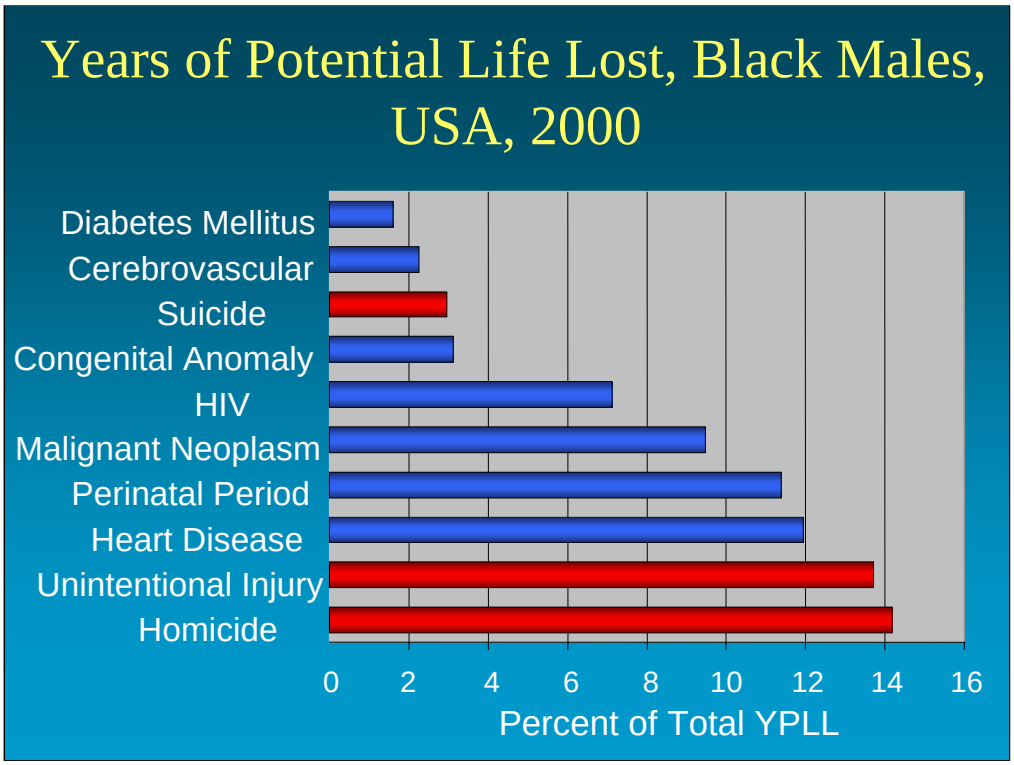
Because of the observations that injuries largely affect the young, several individuals believe that statistics focusing on the number of deaths may underestimate the importance of injuries to society.

Another measure of the burden of injuries is to consider the years of potential life lost. This metric considers not just the number of deaths, but also the age at which the deaths occur. In this measure, a premature death or life year lost is defined by the number of years before age 65 in which the death occurred.



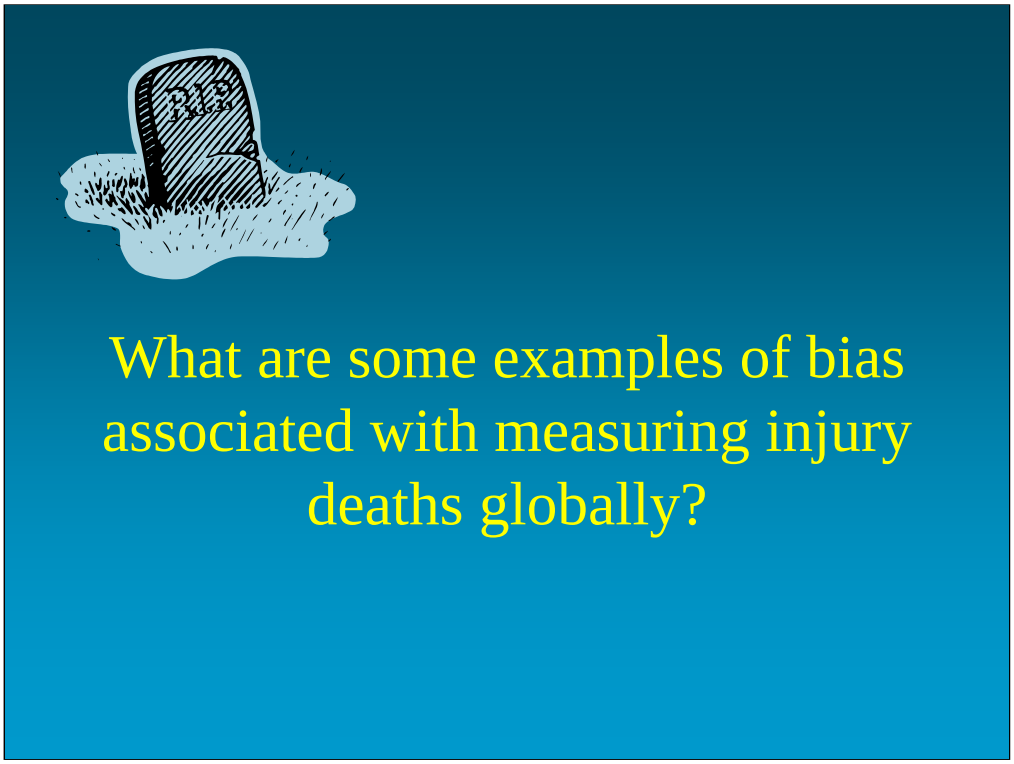
Considering the burden of disease from the perspective of years of potential life lost, we see in this slide that injury is now ranked as the highest burden in the United States. Unintentional injuries are the leading cause for years of potential life lost, followed by cancer and heart disease. Homicide and suicide are also highly ranked.

Note that the data have not changed, only the measure for assessing the burden of disease has changed.



The story is markedly different for African-American males in the United States. Homicide is the condition that leads the list in years of potential life lost. Unintentional injury is ranked second.

Injuries, thus, affect different population groups in different intensities.



Consider the question posed here. If you define bias as the deviation of results from the truth (Last, Dictionary of Epidemiology), list two examples of bias that exist in measuring injury deaths globally.

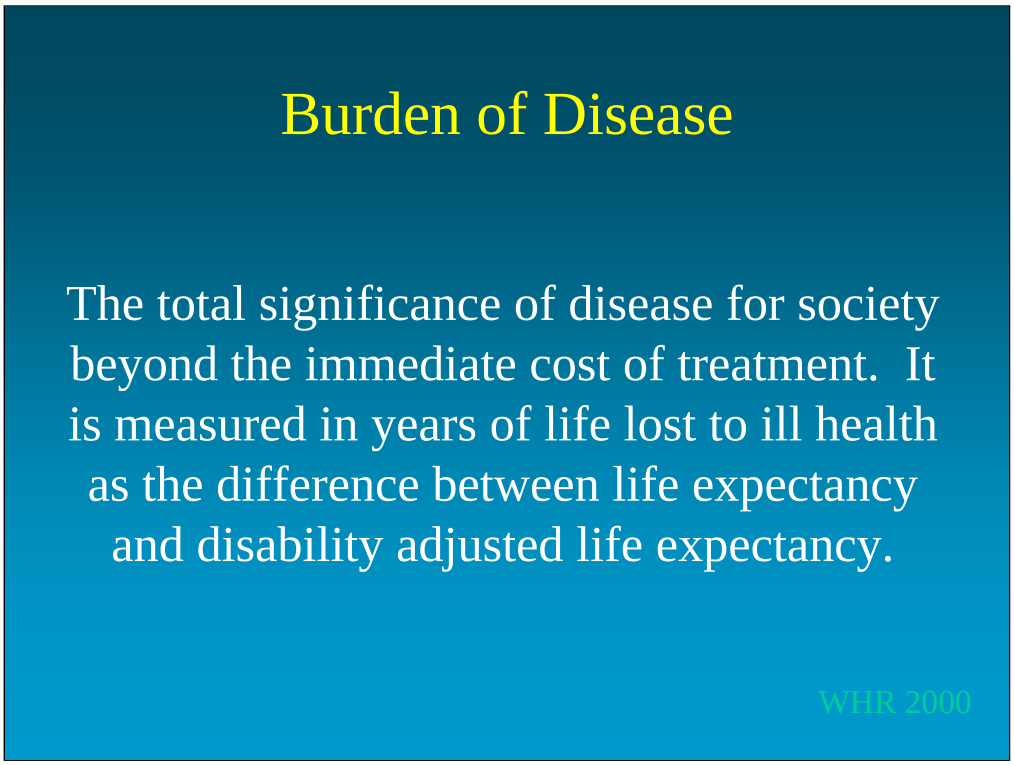
The answer to this question is obviously no! For every person who dies of injuries, data indicate that several thousand persons survive (Krug 2000).

Remember the fundamentals of the injury pyramid. From a absolute number perspective, most injuries are minor and can be treated without any medical attention (represented at the bottom of the pyramid). More severe injuries are fewer in number, but will require medical attention by a professional. Hospitalization from injuries is even less common, and fatalities from injuries (in absolute numbers) are fewer still. Events which result in death are considerably more severe, but occur less frequently.

Thus, the key point here is that an assessment of the burden of injuries that focused only on mortality would seriously underestimate the overall burden of injuries.

How do you begin to consider measuring the impact of non-fatal as well as fatal injuries? Several health endpoints exist. A few examples of health endpoints are illustrated in this slide. Several other examples exist as well.

Differing health endpoints, though, carry differing implications in the assessment of injuries. Hospitalized injuries, for instance, represent acute and severe events. Disability arising from injuries reflects the chronic or long-term aspects that may exist with injuries. Quality of life may encompass both the acute as well as chronic nature of injuries. Several debates exist, though, over the methods to assess quality of life.



The ultimate challenge, then, is to identify a measure of the burden of injury that includes fatal and non-fatal events, assesses both the acute and chronic nature of injuries, and incorporates aspects of quality of life, among other attributes of injury. Unfortunately, no perfect measure exists in this regard.

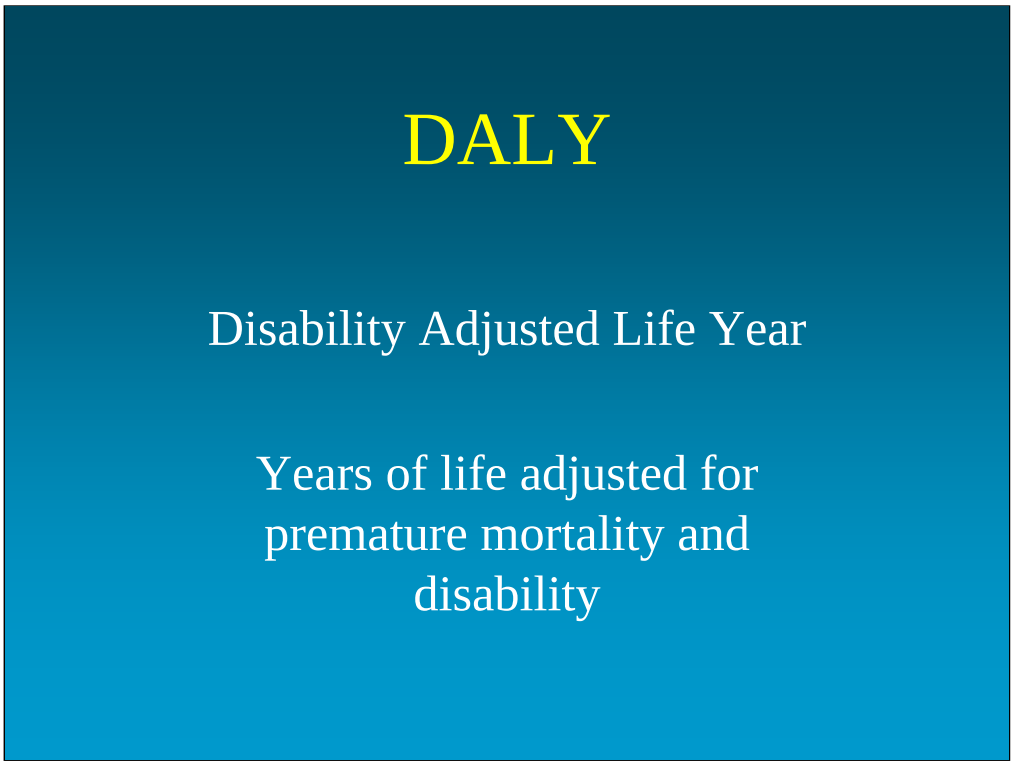
Recent work from Christopher Murray and Alan Lopez provides the most recent measure to address the burden of disease and injuries. This work is entitled the "Global Burden of Disease". If forms the basis for the remaining material presented in this lecture. This measure includes both fatal and non-fatal events, and characterizes the severity of non-fatal events by disability adjusted weights.

The Global Burden of Disease project also is the basis for several projects around the world assessing health policy, disease, and public health.

Several data elements go into the burden of disease measure. These elements include the population estimates for countries, age and gender specific death rates for each country, the distribution of cause of death by country, and estimates of the impact of morbidity. This is valued by considering the degree of disability associated with the condition. Estimates of the number of years living with a disability in the Global Burden of Disease series are calculated by multiplying the number of incident cases of disease in a given period by the disability weight assigned to the condition and the duration of life expected with that disability. Weights have been determined by health state valuation studies.

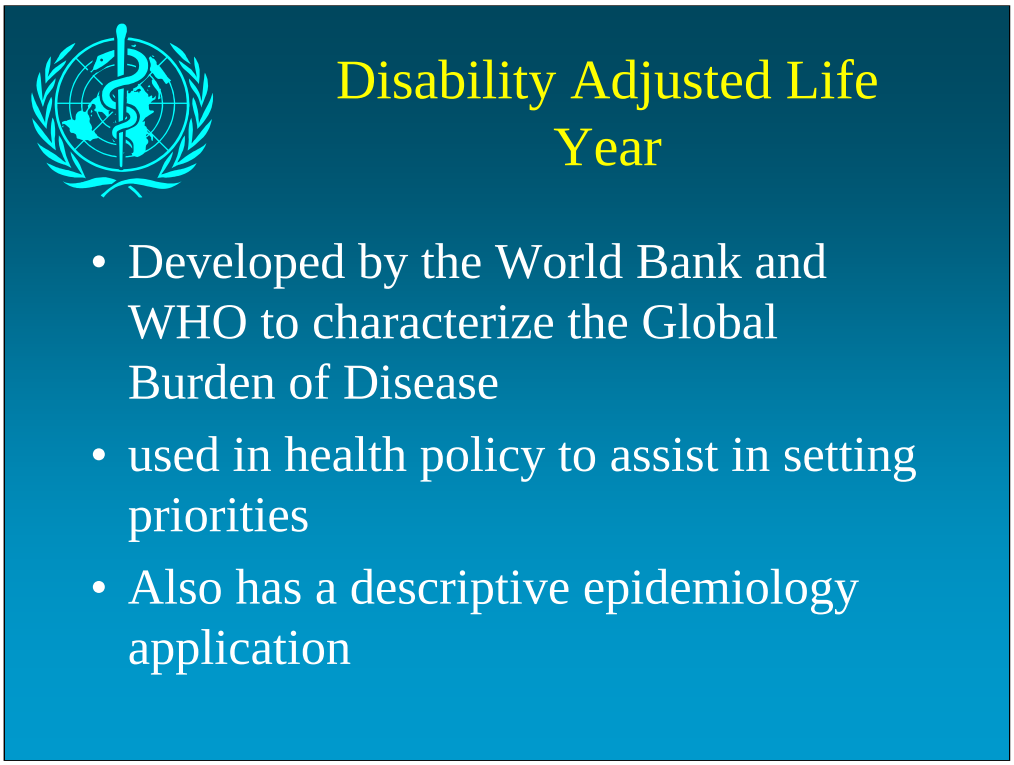
Further reading: The Global Burden of Disease Project; aims, methods, and data sources

Available at:
http://www.hsph.harvard.edu/burdenofdisease/publications/papers/gbd2000.pdf



The Disability Adjusted Life Year metric is the end result of the data and methods of the Global Burden of Disease Project. The DALY is intended to measure the health gap that exists in a given area. The gap is considered the difference between current health status and the ideal (where a person lives into old age free of disease and disability). One DALY is equal to one year of healthy life lost.

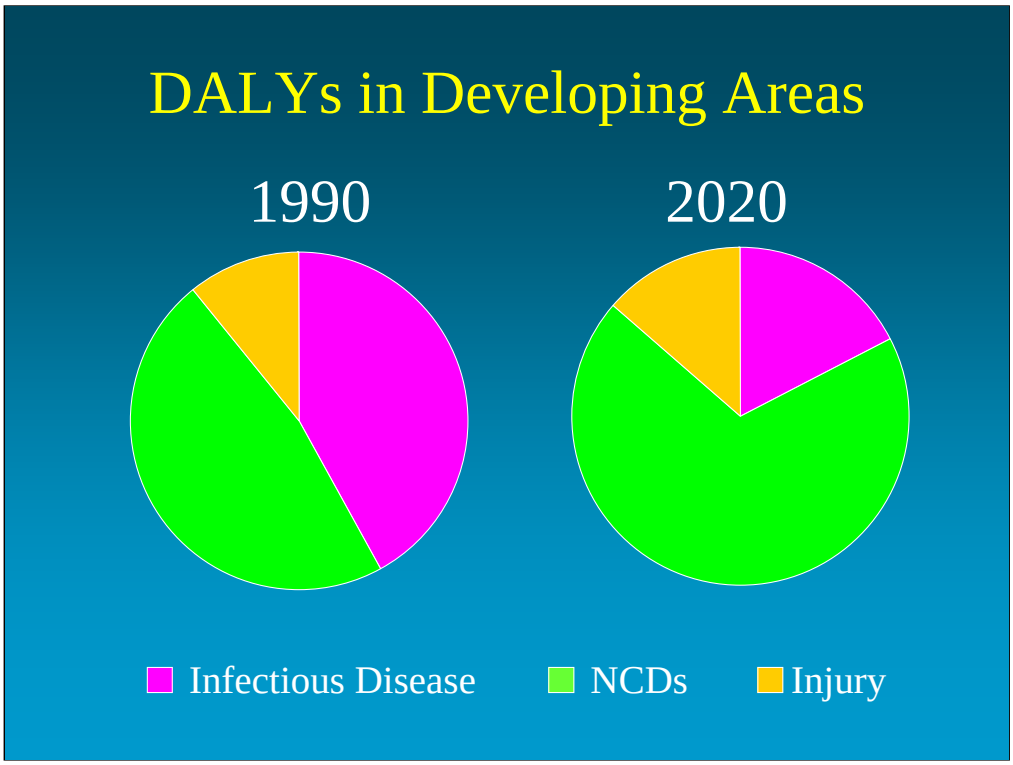
The DALY includes premature mortality and the impact of living with a disease or injury that has disability associated with it.



The DALY metric was developed in the early 1990s. It has been used in work by the World Bank and WHO to assess health policy and argue for priority setting in human health.

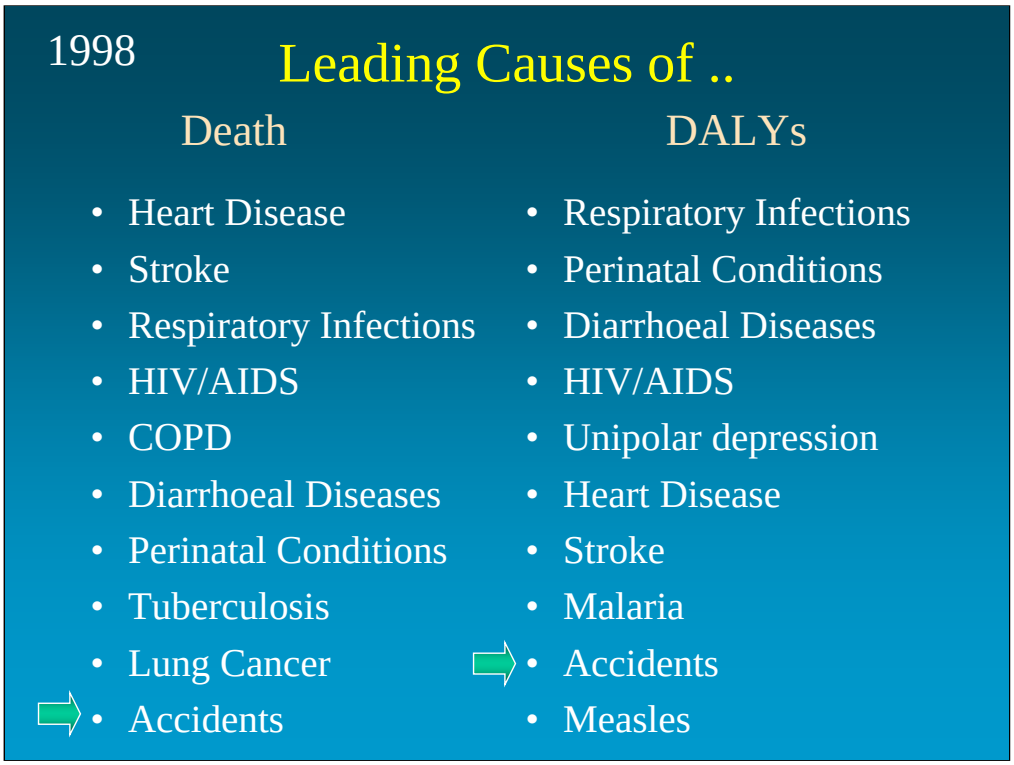
A review of the development of DALYs is available in the reference below.

See: Murray CJL, Salomon JA, Mathers CD. A critical examination of summary measures of population health. *Bulletin of the World Health Organization* 2000, 78(8):981-994.

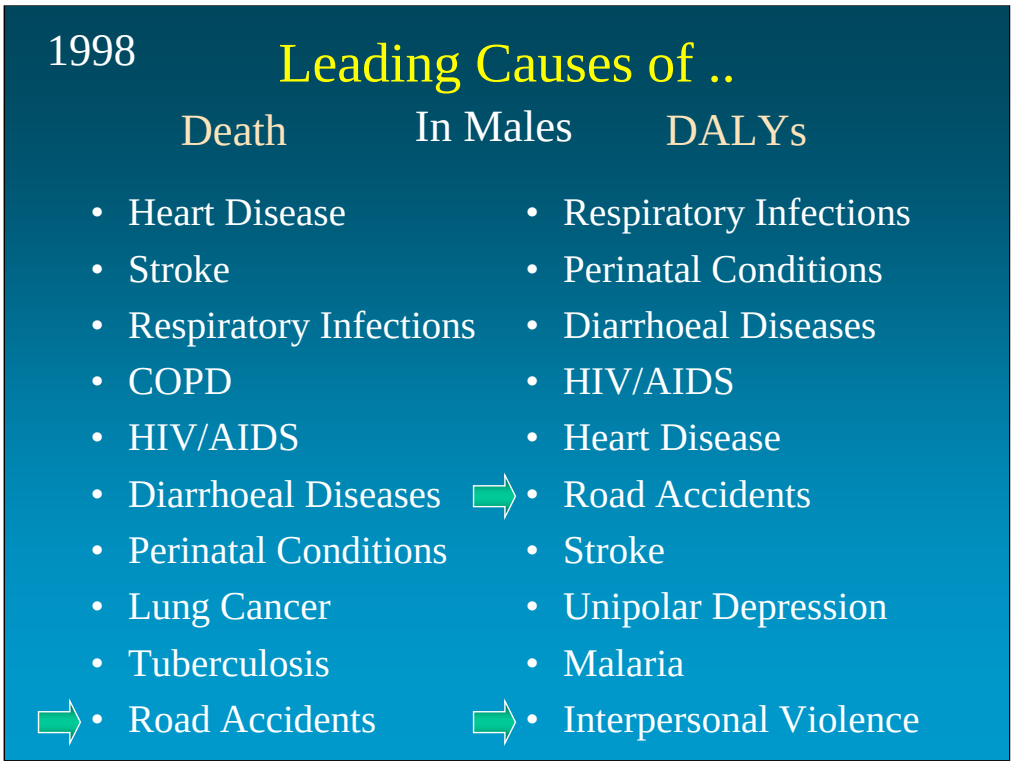


The burden of disease and injuries in developing countries is highlighted in this slide. Projections based upon the Global Burden of Disease Project methods indicate that DALYs related to chronic disease (NCDs) will increase significantly by 2020 in developing countries. The burden of infectious disease will decline significantly. The burden of injuries is expected to increase, though not at the same level as observed for chronic disease.

See: The Global Burden of Disease, Murray CJL, Lopez AD (eds), Harvard University Press, Cambridge MA, 1996.

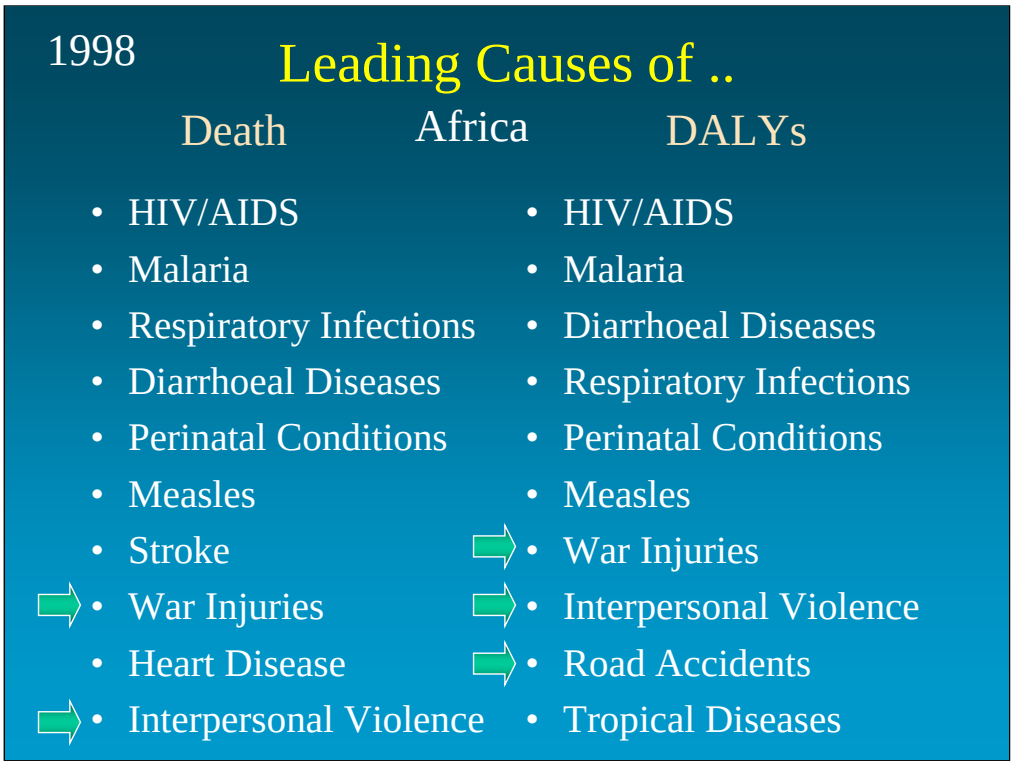


Globally, it is estimated that 5.8 million people died from injuries in 1998 (Krug, 2000). Road Traffic Accidents are ranked as the 10th leading cause of death. When considered from the perspective of disability adjusted life years, road traffic injuries rank as the 9th leading cause of DALYs lost.



About 3.8 million males died from injuries in 1998 (Krug 2000). The picture related to injury deaths is similar to that seen before for overall deaths. Injuries from road traffic accidents rank as the 10th leading cause of death. However, when DALYs are considered, both road traffic accidents and interpersonal violence are in the top ten list of leading causes of DALYs lost.

Interpersonal violence includes homicide and assault.



The burden of injury also differs by region of the world. The overall burden of disease for Africa is illustrated here. Injuries related to war and interpersonal violence are significant issues, both for mortality and morbidity.

Leading Causes of Injury Death by Region, 1998

Region	Rank 1	Rank 2	Rank 3
Africa	War injuries	Assault/Homicide	Road accidents
Americas (high income)	Road accidents	Self-inflicted	Assault/Homicide
Americas (low income)	Assault/Homicide	Road accidents	
EMRO (high income)	War injuries	Road accidents	Self-inflicted
EMRO (low income)	War injuries	Road accidents	Assault/Homicide
Europe (high income)	Road accidents	Self-inflicted	
Europe (low income)	Road accidents	Self-inflicted	War injuries
India	Road accidents	Fires	Self-inflicted
SE Asia	Road accidents	Self-inflicted	
China	Self-inflicted	Road accidents	Drowning
W. Pacific (high income)	Road accidents	Self-inflicted	
W. Pacific (low income)	Road accidents	Drowning	Self-inflicted

WHO 1999

Looking now at just injury deaths by region of the world. The patterns of injury deaths differ by region. In high income countries, the typical pattern is to see road traffic injury deaths are the main injury event, followed by suicide. In Africa and the middle east, war injuries are the primary injury event. The Americas also have a concern regarding interpersonal violence. Note, India, where fire related deaths are also important.

In a global context, injuries are one of the most important health issues faced by governments and individuals. The rationale for injury prevention exists worldwide.