Injury Epidemiology

An Introduction

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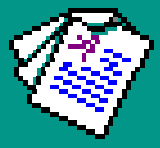
readings



This lecture introduces an emerging topic in global health today; injury epidemiology. Injuries represent a significant burden today in both developed and developing economies. They capture our interest very frequently through catastrophes such as an airplane crash or the motor vehicle crash in which Princess Diana died. Several individuals are working actively today to reduce their burden into the future. Many questions remain about the most appropriate way to do this.

What are Injuries?

We begin by asking the broad questions of “What are Injuries?” Why should we have an interest in injuries and research into the epidemiology of injuries?

Causes of Injuries

- Abnormal Energy Transfer
  - Mechanical Energy (moving objects)
  - Thermal
  - Electric
  - Chemical
  - Radiation

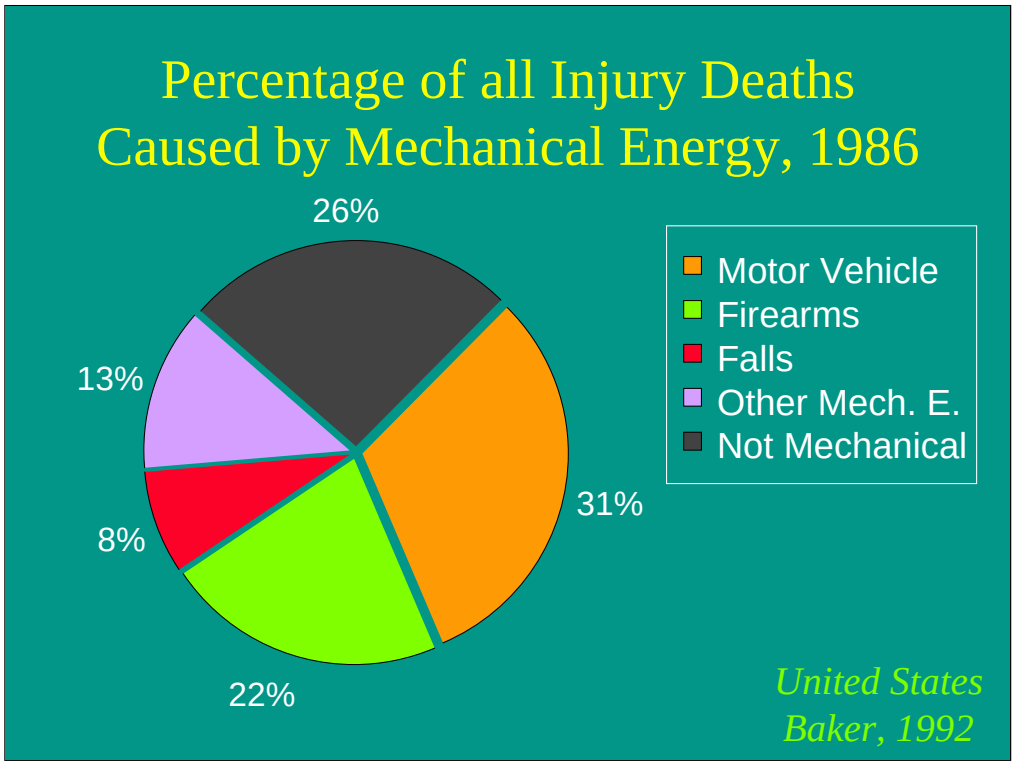
All injuries can be characterized from the perspective of an abnormal transfer of energy. For example, the catastrophic injuries arising from plane or automobile crashes can be characterized as injuries which arise from the transfer of energy between the victim and a stationary object (the ground) or a moving object (another vehicle), which lead to trauma and possibly death.

Interference with normal energy exchange may also result in injuries through drowning and frostbite.

Energy Transfer and Injuries

- Penetrating
- Non-Penetrating
- Compression
- Burn

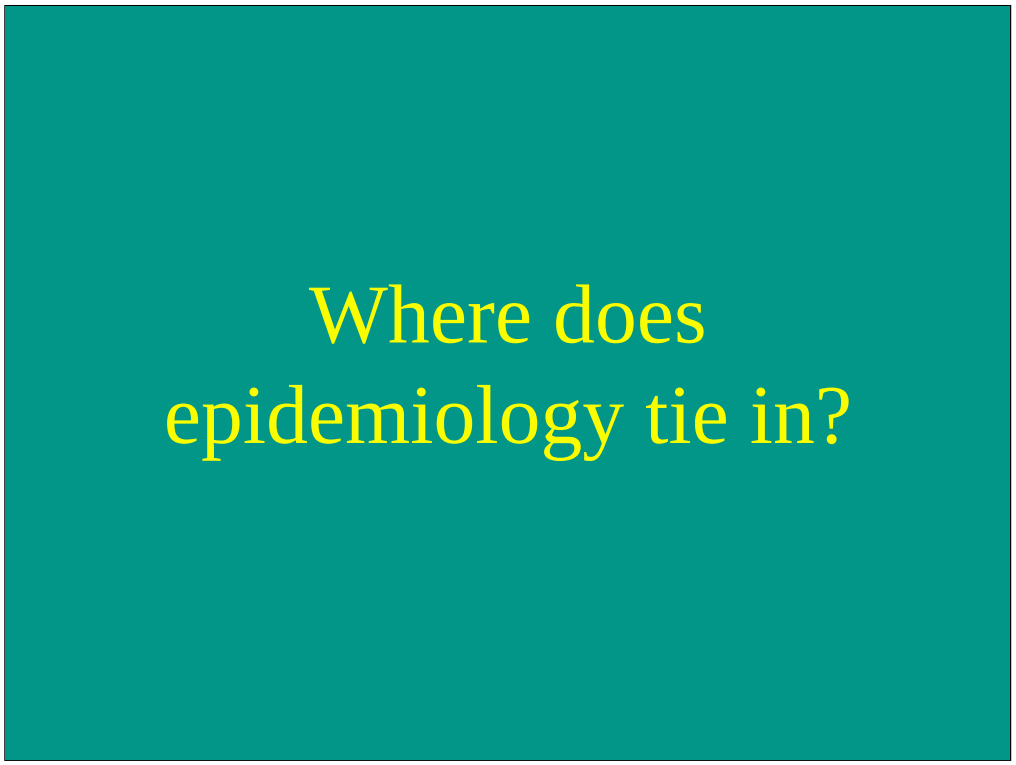
If the energy transfer is localized in one area, the likely outcome may be a penetrating injury. If the energy transfer is dispersed over a broad area, the result will often be a non-penetrating injury. In situations involving thermal energy transfer, the result will be a burn. And so on, depending upon the mode of energy involved.



Most injuries (74%) arise from the abnormal transfer of physical or mechanical energy. This is due to the frequency in which we come into contact with events and vehicles that involve mechanical energy. The leading causes of death from mechanical energy transfer are injuries from motor vehicle accidents, firearms, and falls.

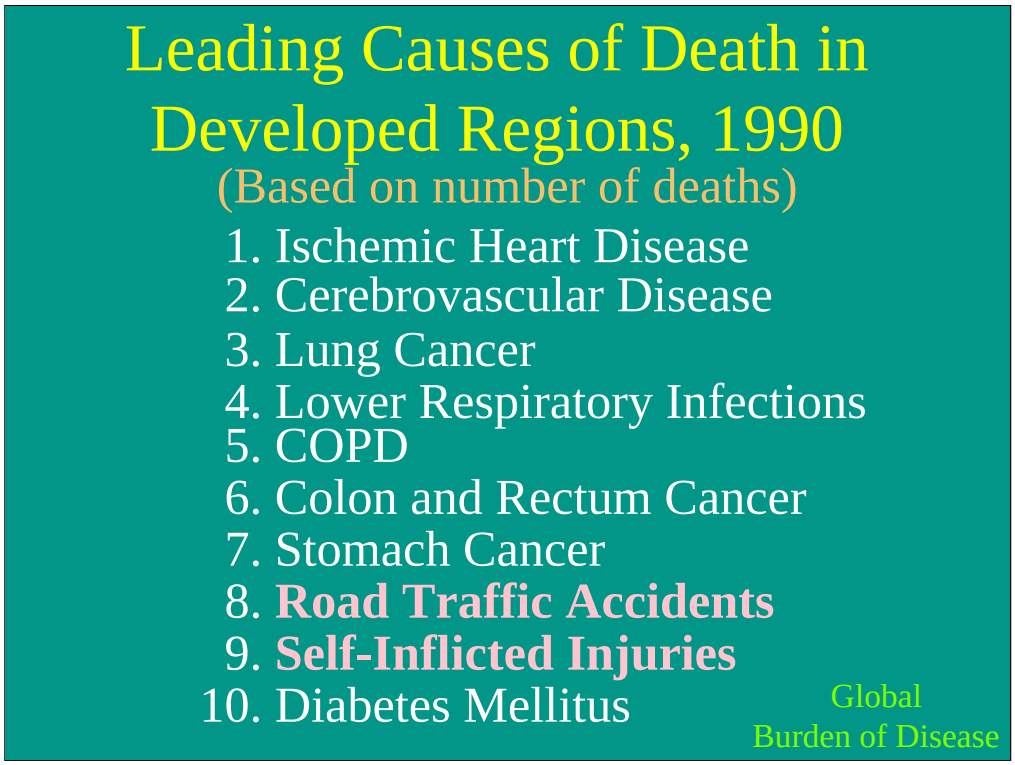
- Motor Vehicle Crashes
- Homicide
- Suicide
- Sports and Recreation
- Drownings
- Poisonings
- Falls
- Occupational Injuries
- Burns
- Asphyxiation

There are several different types of injuries, though, which may occur from abnormal energy transfer. The leading categories of injuries are shown here. Often, the epidemiologic characteristics of the categories are different.



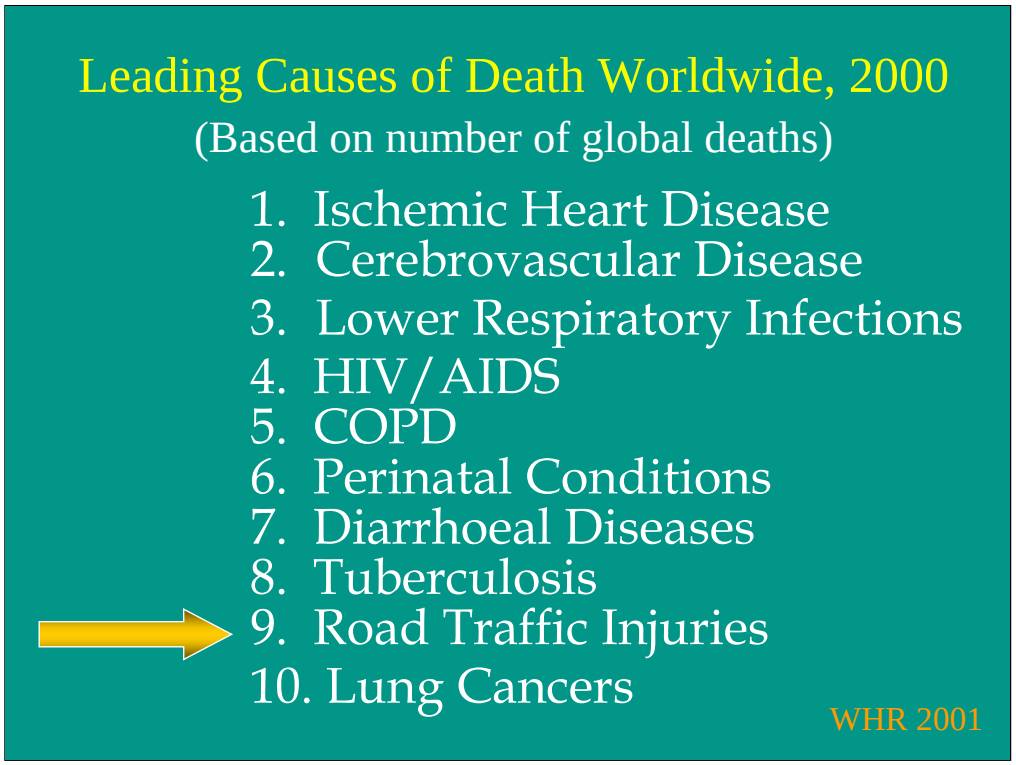
Why have epidemiologists taken an interest in injuries? Foremost, injuries have been identified through monitoring systems as a leading cause of mortality and morbidity in both the developed and developing world. Like other non-communicable diseases, they present a challenge to epidemiologists to both understand the basic underpinnings of their occurrence (the frequency in which they occur, and the risk factors for their occurrence) and to develop intervention programs to reduce their impact.

Secondly, the work of William Haddon has elegantly outlined how epidemiologic applications have relevance to injuries. This will be discussed in more detail later in the lecture.



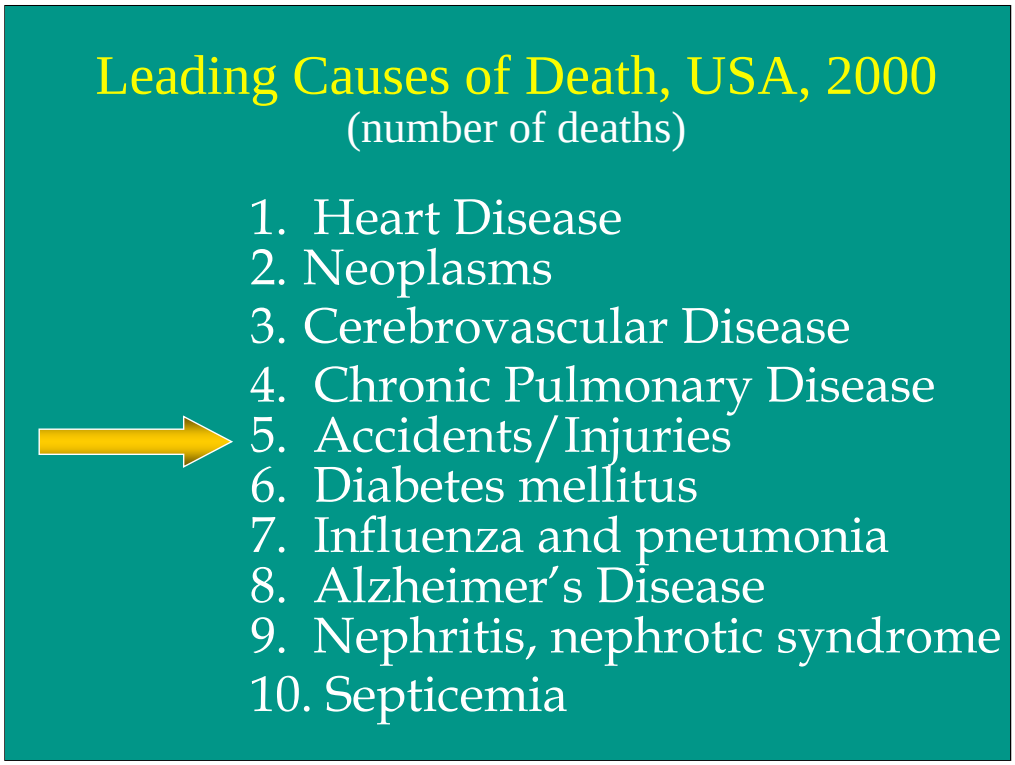
Data systems have clearly identified injuries as a leading cause of death throughout the world. Christopher Murray and Alan Lopez have reviewed the leading factors behind mortality and disability on a global basis. This work is presented in their book, "The Global Burden of Disease", Harvard University Press, 1996. Among the countries in the developed world, injuries from motor vehicle accidents are the 8th leading cause of death. Suicides are the 9th leading causes of death. The impact is greater if the cancer categories are grouped together.

In the developing world, recent evidence suggests that injuries are assuming a greater importance as a cause of death and disability. In 1990, deaths from road traffic accidents were the 10th leading cause of death in developing regions. Further, the impact of injuries from accidents are projected to increase dramatically to the year 2020.

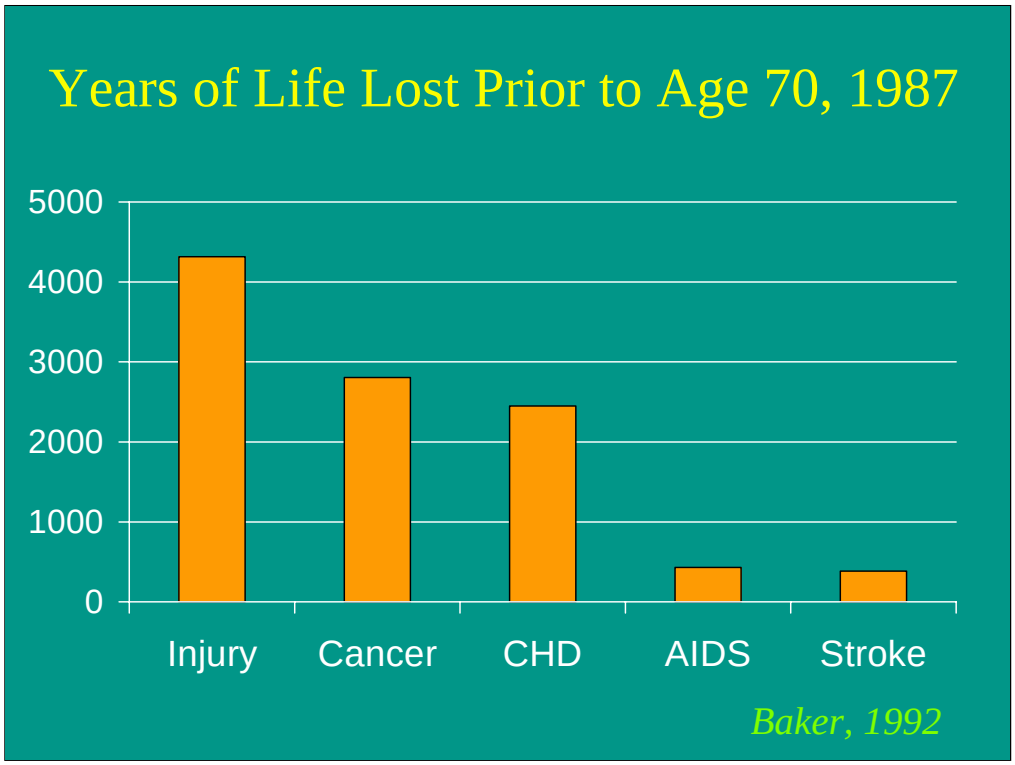


Using more recent data, for 2000, we see, worldwide, that road traffic accidents are a significant health issue. Injuries are ranked as the 9th leading cause of death worldwide. Some estimates place the figure at about 1 million deaths a year worldwide from road crashes.

In the United States, deaths from homicides (intentional injuries) enter the picture as an important category. Homicides were the 10th leading causes of death in 1992.



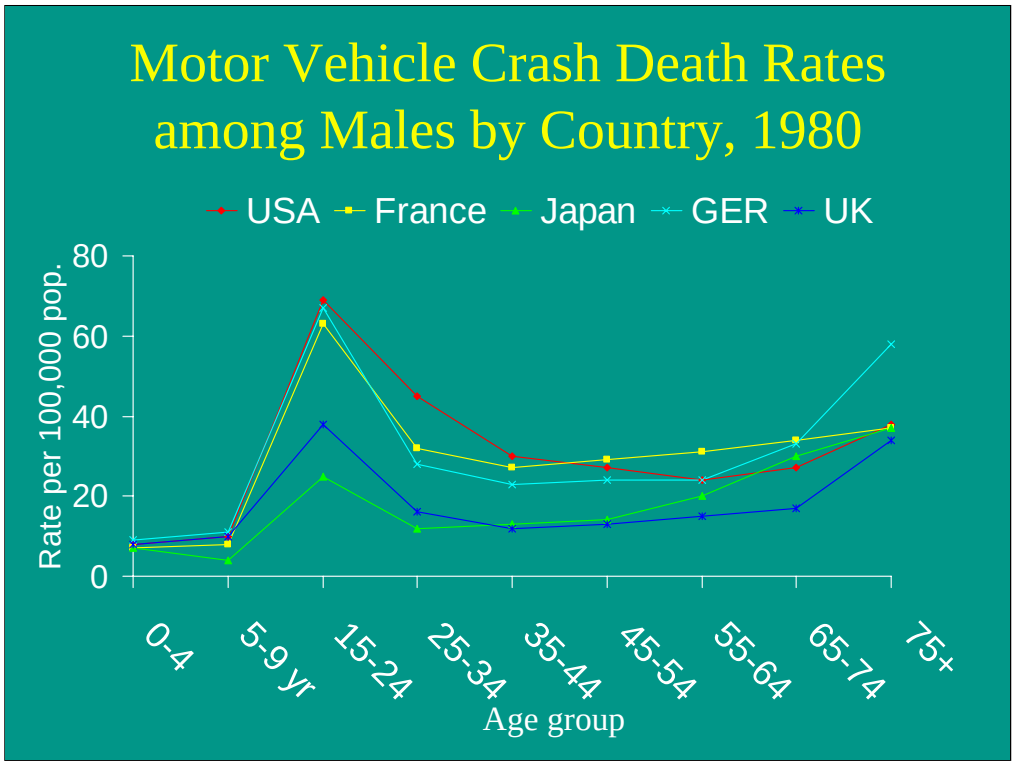
More recent data on the leading causes of death from the year 2000 are shown in this slide. Unintentional injury deaths are still ranked as the 5th leading cause of death (these are primarily deaths from motor vehicle crashes). However, the impact from homicide and suicide has lessened over time. They are no longer listed among the 10 leading causes of death….. Though they remain in the 15 leading causes.



The largest impact of injuries is focused upon the young. Injuries are the leading cause of death and years of life lost for persons under age 45.

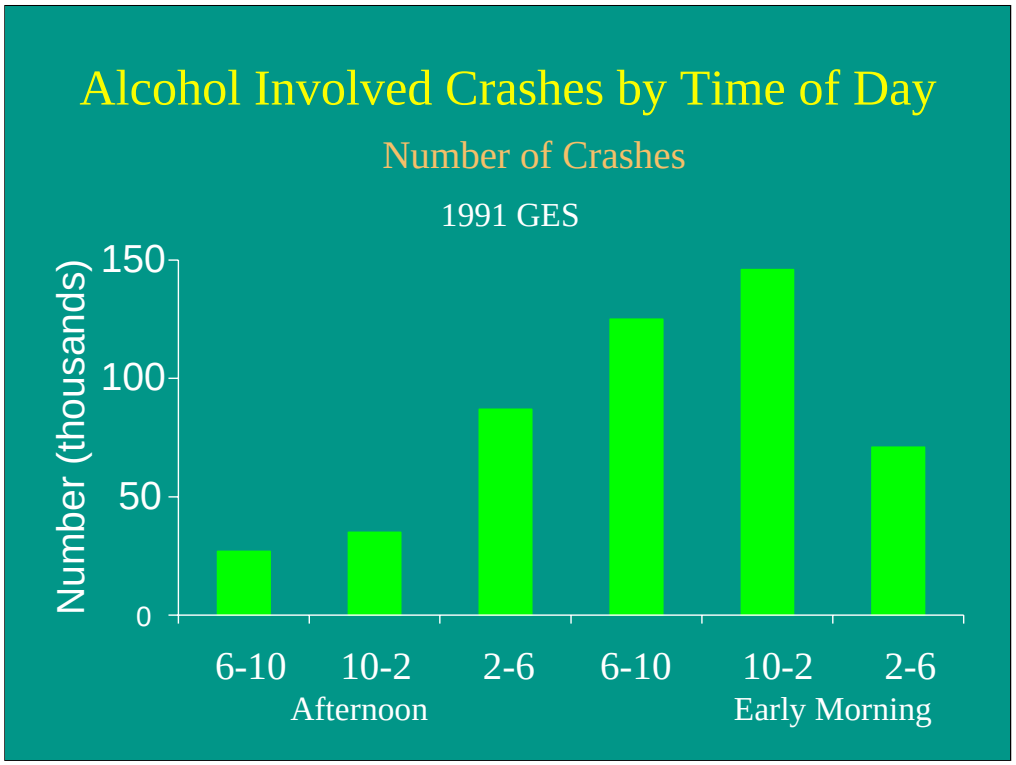
This impact is common to both areas with developed economies and those whose economies are developing.

Injuries also represent a significant burden from the standpoint of costs. The total lifetime cost of injury to the United States in 1988 was estimated at $180 billion. These include costs for medical treatment, as well as the costs associated with lost productivity and premature mortality.



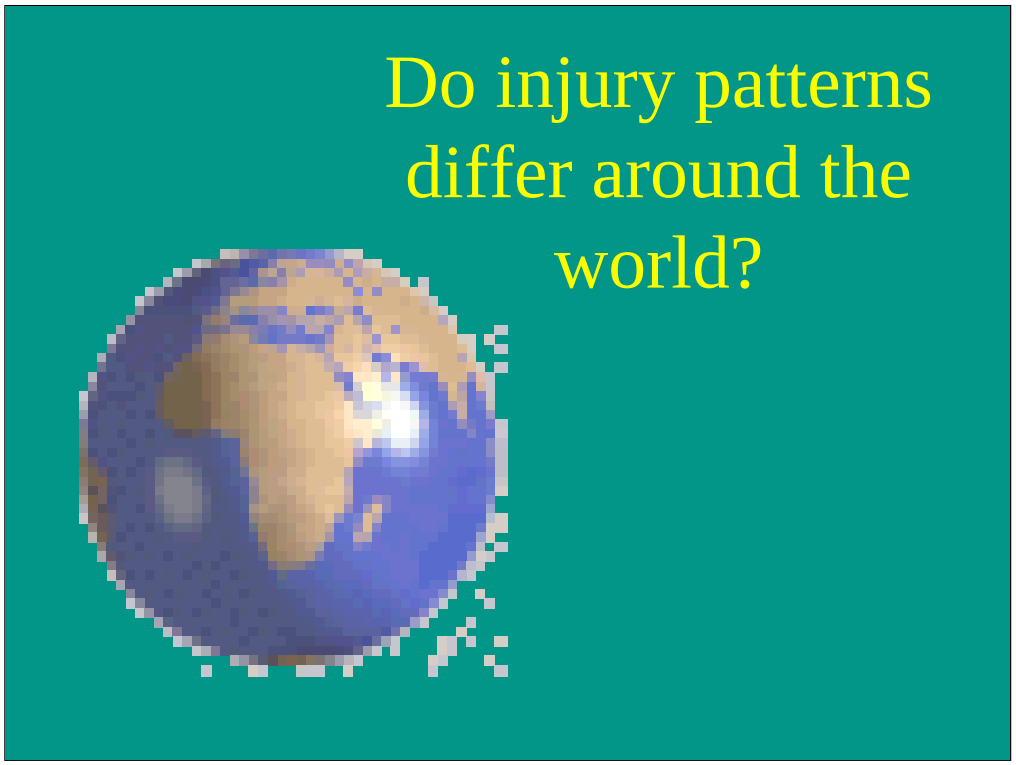
"Injuries are not Accidents". This is a common statement spoken by injury research professionals. The basis for this statement lies in our understanding that injuries most often occur to certain risk groups and are fairly predictable in their occurrence (whether it be to certain persons, at certain times, or in common locations). Whereas, with accidents, events are generally random in nature.

For example, in motor vehicle accidents there are common observations that crash risks are higher among males, and among the young, and increases in the very old. We see here that the age relationship is fairly consistent across several countries.



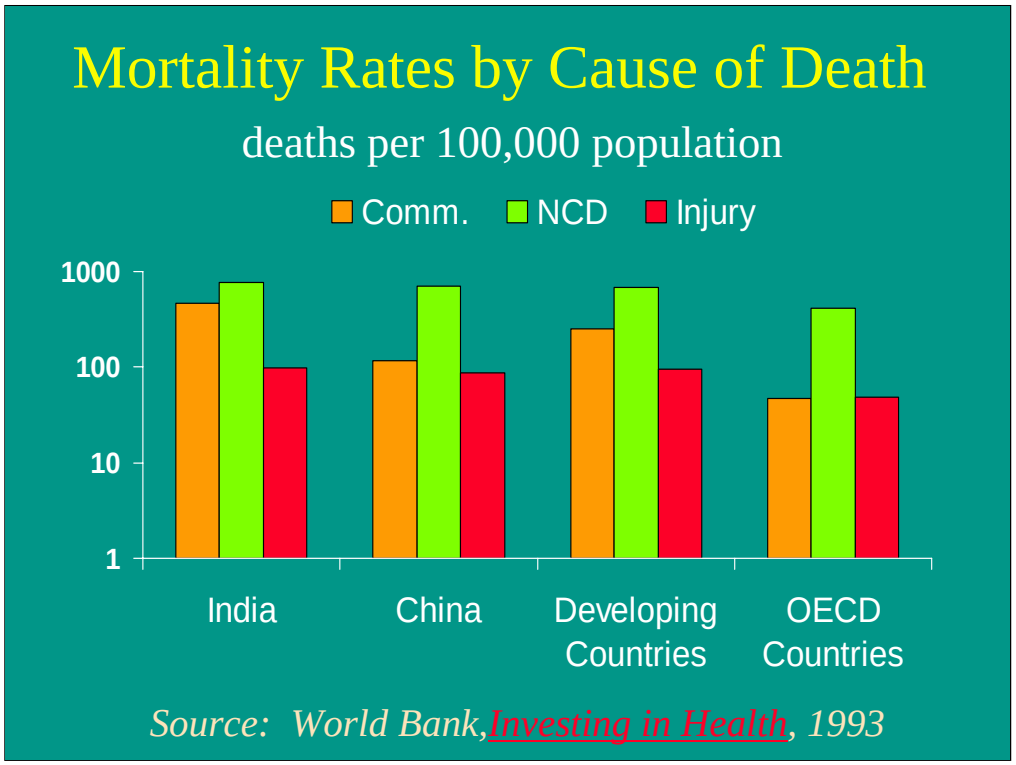
Alcohol is another major factor involved in motor vehicle crashes. In some areas, alcohol-related crashes account for one-half of all fatalities in motor vehicle accidents.

Again, what is predictable regarding alcohol-involved crashes is the time of day when they are most likely to occur. We see here that the evening hours are much more dangerous from this perspective.



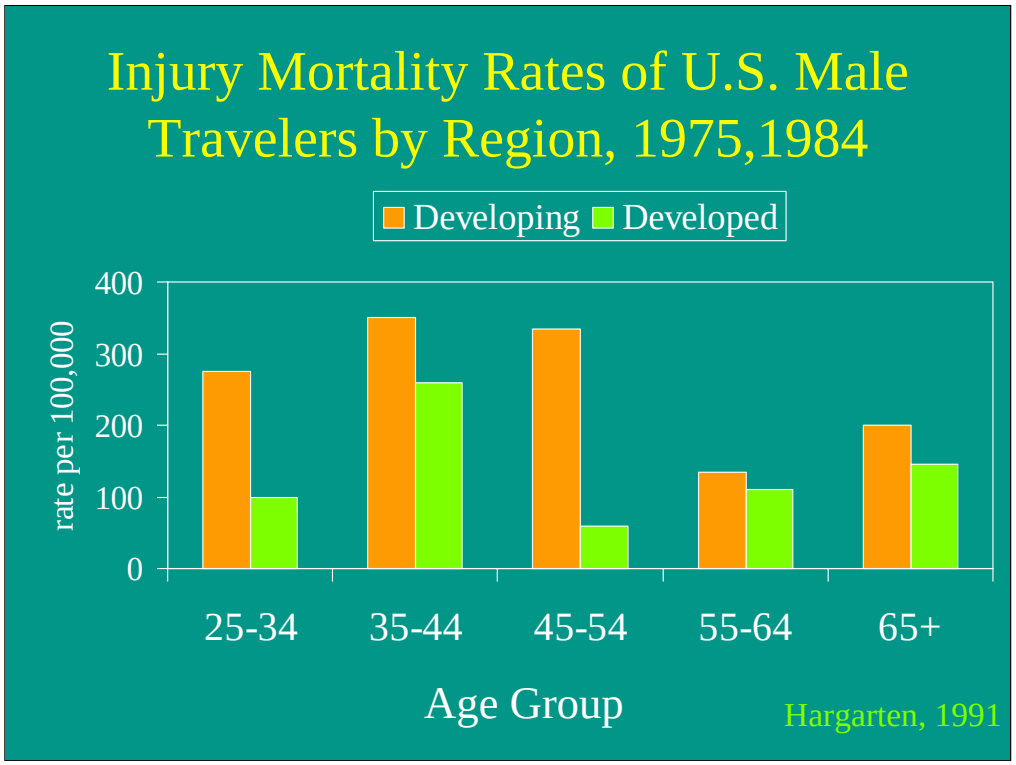
There is ample indication in the mortality statistics that the importance of injuries differs markedly by country throughout the world.

There is some debate, though, regarding the association between injury mortality and morbidity and economic development. Some individuals argue that injury morbidity and mortality is higher in developing countries, while others present information to demonstrate the opposite.



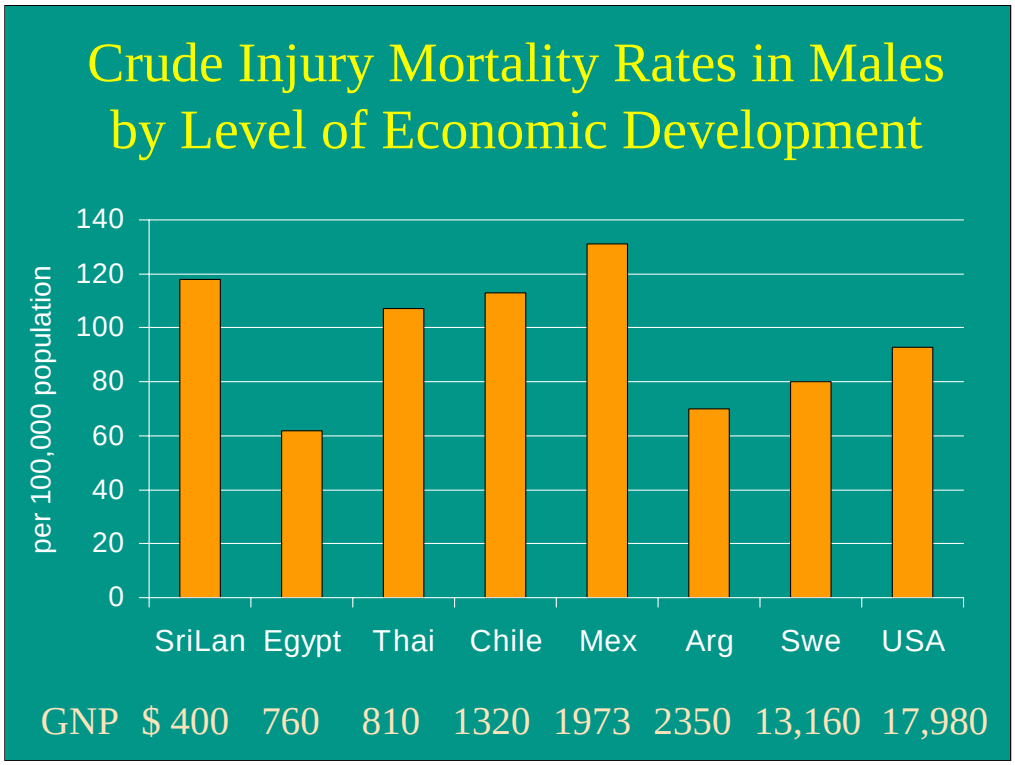
On a global basis, an analysis by the World Bank in their seminal publication, "Investing in Health", suggests that injury mortality rates are higher in developing countries (94 injury deaths per 100,000 population) when compared to the developed economies of the Organisation for Economic Cooperation and Development countries (49 injury deaths/100,000 population.

Reasons for this observation are not entirely clear. One hypothesis is that there may be fewer integrated injury control efforts in these areas. Another hypothesis is that there may be higher rates of occupational injuries in developing economies, where priority is given to employment rather than health. However, the evidence regarding both theories is debatable.

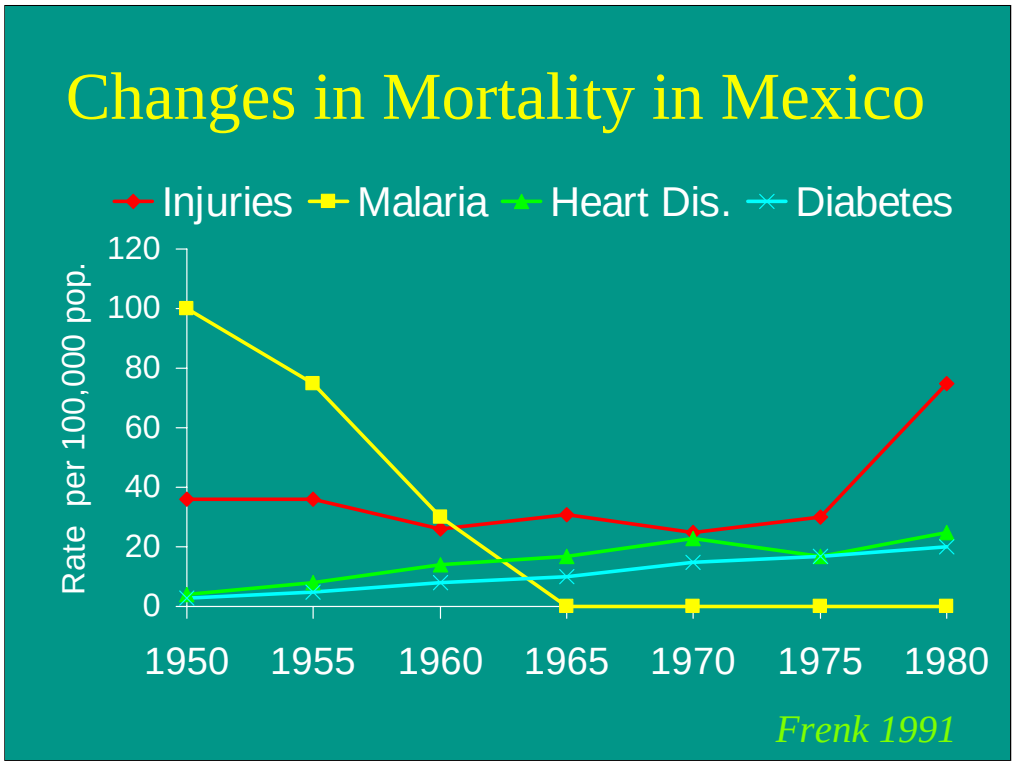


Similarly, a study of causes of death amongst United States citizens travelling overseas found consistently higher injury death rates for travelers to developing countries as opposed to travelers to developed countries.

Source: Hargarten SW, Baker TD, Guptill K. Overseas fatalities of United States citizen travelers: an analysis of deaths related to international travel. Annals of Emergency Medicine 20(6):622-626, 1991.



On a national basis, however, the argument is much more chaotic. The theory of declines in injury mortality with economic progress does not exist in some areas. Within both developed and developing countries, wide variations exist in injury mortality rates. For example, deaths from injuries are higher in the USA than in Sweden. What factors may account for this observation?

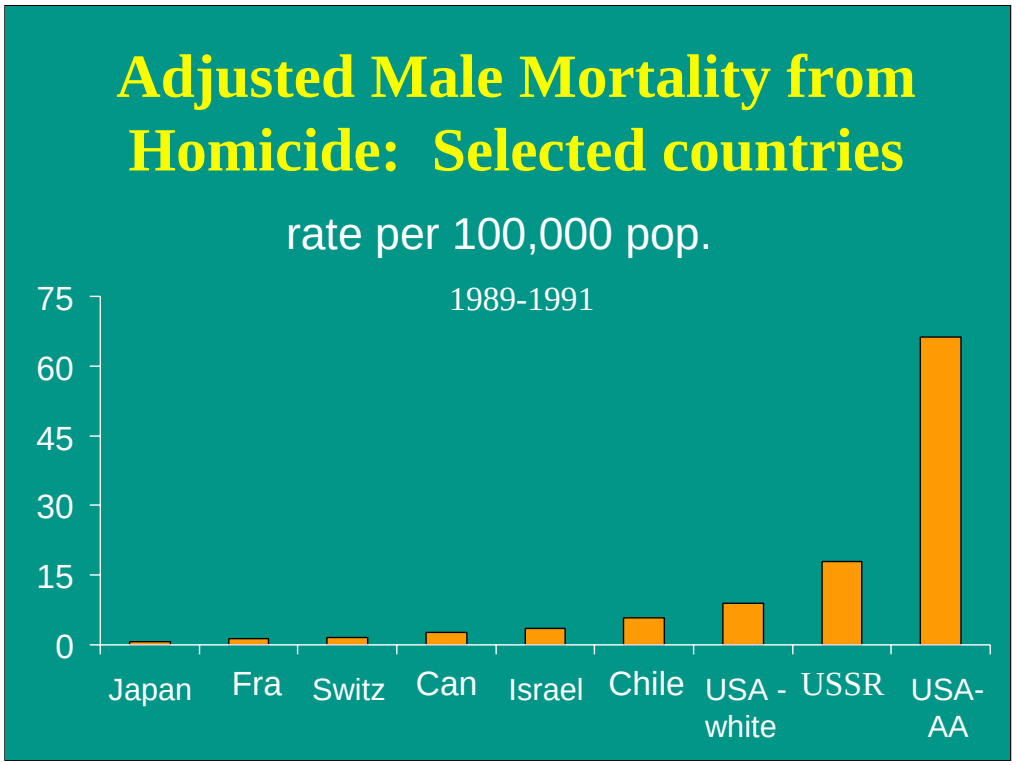


In another example, deaths from injuries in Mexico appear more common than those in Egypt or Chile. In Mexico, mortality rates from injury have actually increased with development. What events could explain this observation?

Several factors may be important for explaining the variations noted between countries.

1. The item of comparison, injury mortality, is quite broad. Injuries encompass a wide variety of categories, from accidents to homicides to falls and poisonings
2. Injuries from one of the categories, e.g. crashes or violence, may be more common in some areas
2. Public transport systems may be better developed in some areas
3. Economic development in its initial stages may lead to higher rates of occupational injuries.

Can you think of other reasons?



Certainly, there is evidence to suggest that patterns of specific injuries differ by country. Injuries from violence differ markedly. African Americans in the USA have one of the highest homicide rates in the world.

Injury Control

What is injury control? In it's simplest form, injury prevention and control represents a reduction in the incidence and/or prevalence of an injury.

Definitions

Prevention

- Reducing the incidence of disease
- Reducing the prevalence of disease

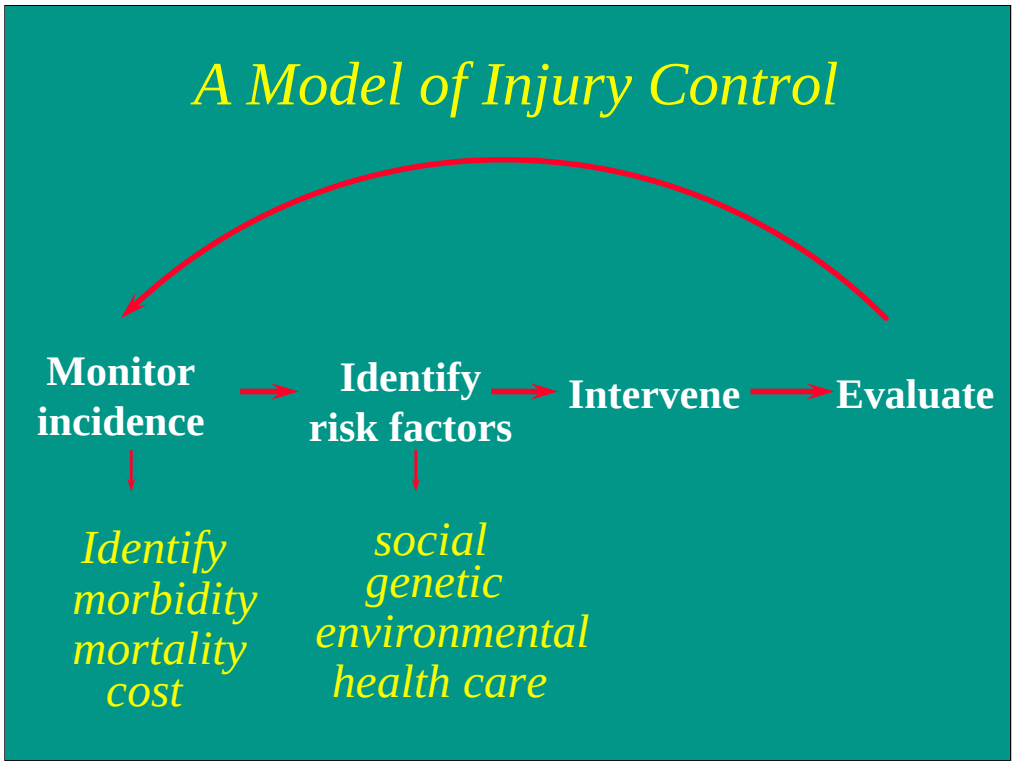
Control

- Ongoing programs aimed at reducing the incidence and/or prevalence of disease

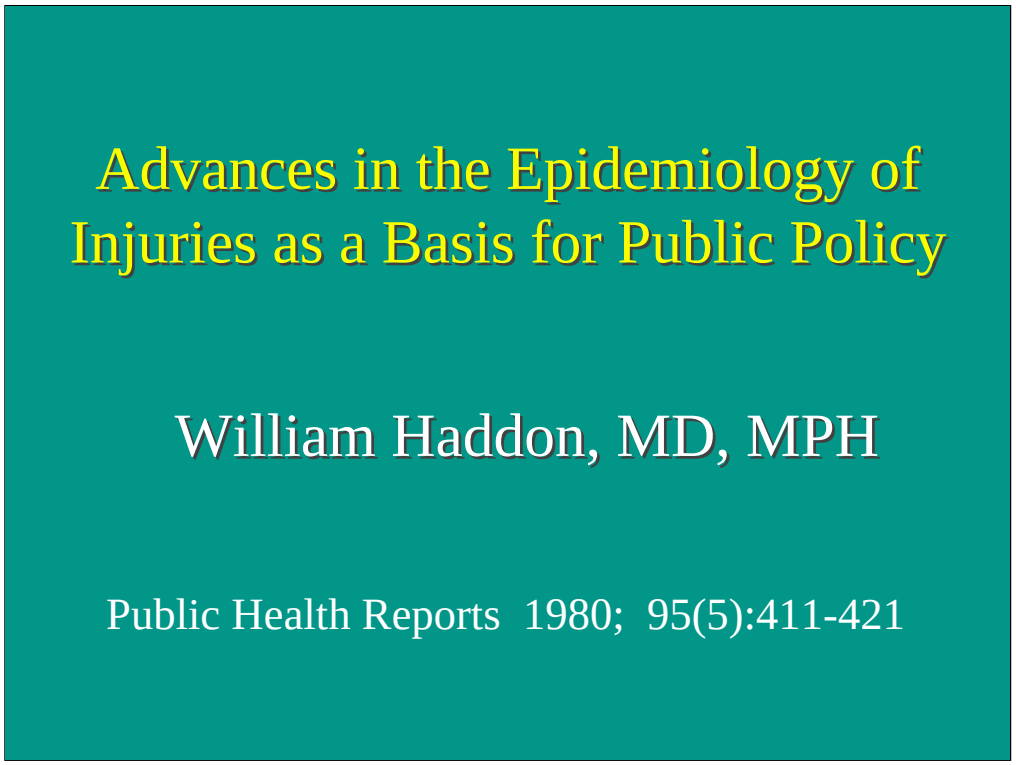
Last, Dictionary of Epidemiology

John Last has defined the terms “prevention” and “control” in the noted manner in the Dictionary of Epidemiology (Oxford University Press).

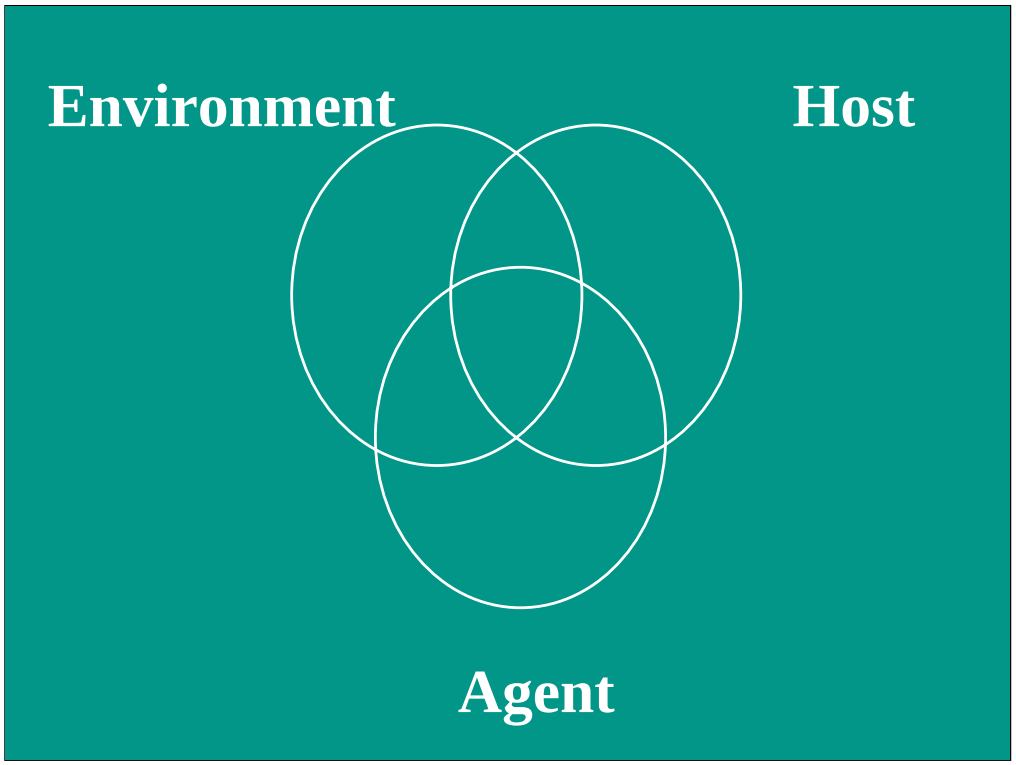
Prevention of injuries is characterized by a reduction in the incidence of injury events. Injury control denotes the programs that seek to reduce the frequency and severity of injuries.



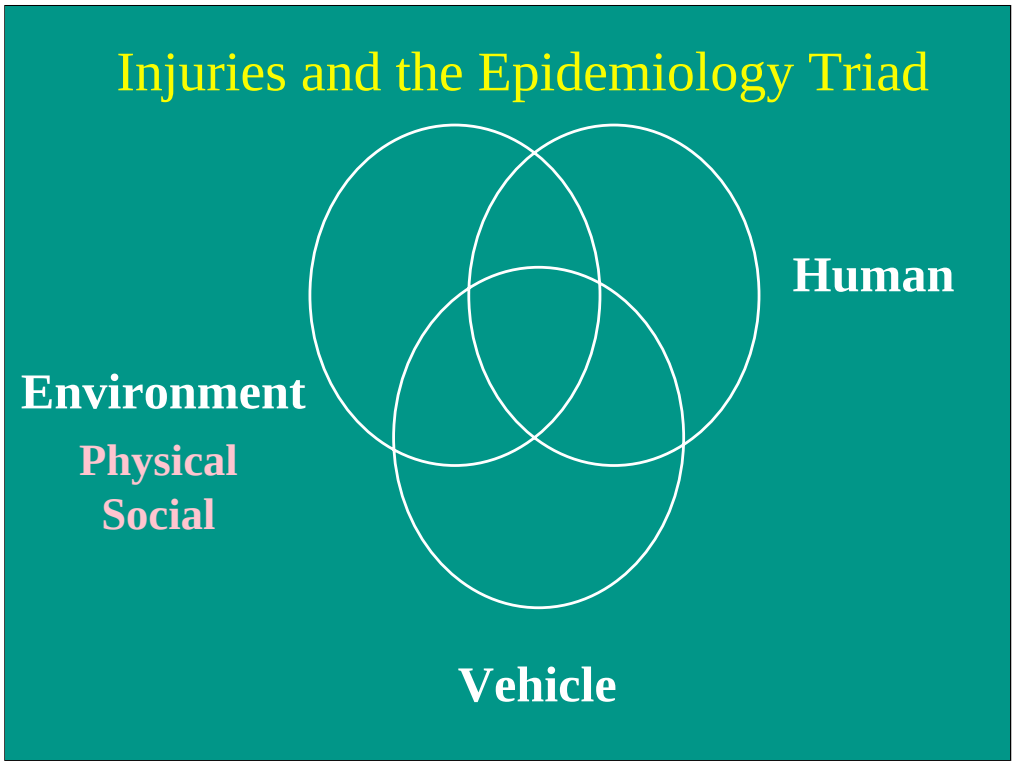
Most injuries are preventable events. In looking at the public health model to disease control, we can picture the processes in which injury control programs fit. Injury control programs develop from our understanding of both the frequency in which the events occur (through monitoring), but also the risk factors that lie behind their occurrence (through analytic epidemiologic studies).



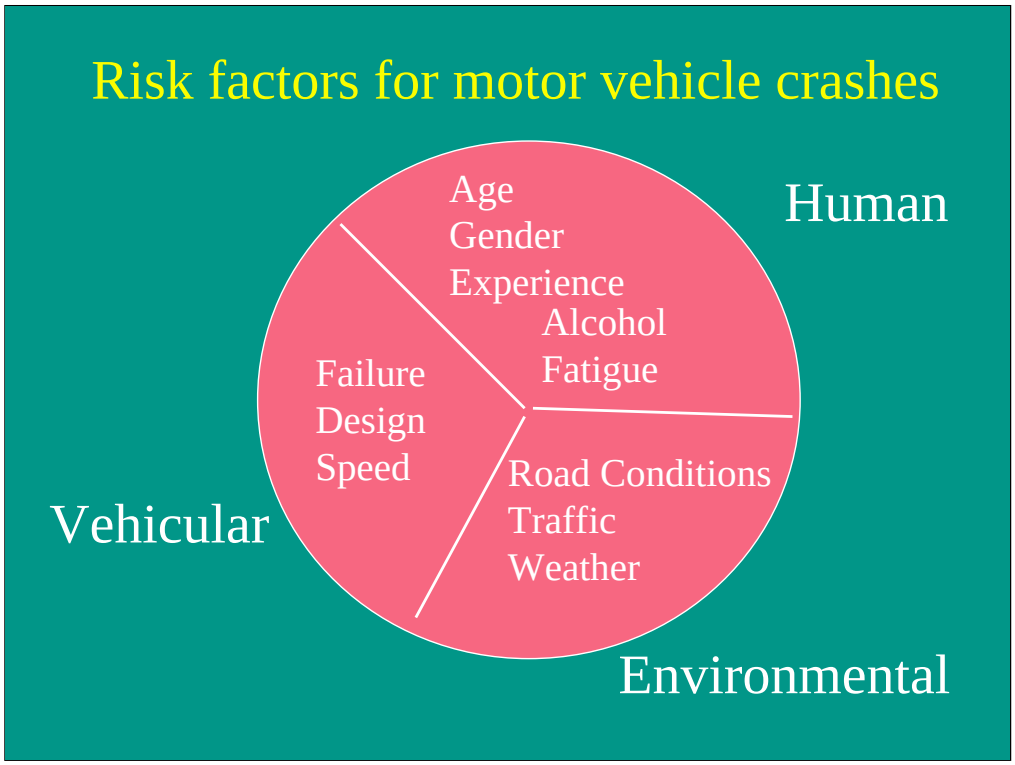
Without a doubt, the father of injury epidemiology and injury control is William Haddon. The former director of the National Highway Traffic Safety Administration and the Insurance Institute for Highway Safety played a leading role in bringing epidemiologic principles to injury research and intervention programs.



The basic argument of Haddon was that injuries could be easily examined from an epidemiologic framework. In it's classic sense, epidemiology considers the interaction of three factors in the development of disease; the host, the agent, and the environment.



Haddon applied this philosophy to injuries, and most often to injuries from motor vehicle accidents. The host is the human being and their behavior in operating the vehicle. Physical energy is the agent in injury events. For motor vehicle events, this translates into the physical energy involved with motor vehicles. The environment is the milieu in which the vehicle and the human are interacting, such as the type of road, the weather conditions involved, etc.



Here we see an example of the risk factors identified for motor vehicle accidents within the framework of the epidemiologic triad.

The Haddon Matrix

use for planning, resource allocation, strategy identification

	Human	Vehicle	Environment
Pre-event			
Event			
Post-event			

Haddon extended the epidemiologic triad further, though, to consider these factors in unison with the crash sequence. The crash sequence can be examined in terms of three items; the circumstances surrounding the event prior to the crash occurring, the circumstances involved during the crash, and those involved after the crash. The crash sequence interacts with human, environment, and vehicular factors to define the frequency and severity of injury.

The Haddon Matrix

	Human	Vehicle	Environment
Pre-event	alcohol		night, rain
Event	no seat belt	no air bag	tree too close to road
Post-event			slow emergency response

The Haddon Matrix changed our view of injuries from motor vehicle accidents and other injuries and provided a framework for the development of injury control interventions. Haddon's argument was that an appropriate understanding of the factors affecting injuries in each cell of the matrix could lead to more effective interventions. By identifying which factors are important and their location in the crash sequence, it will then be possible to understand where interventions may be most appropriate. Haddon applied this matrix to several other injuries in addition to those from motor vehicle crashes.

Crash Injury Prevention Strategies for the International Traveler

	Traveler	Vehicle	Environment
Pre-event	Avoid alcohol	Choose safe cars	Avoid night driving
Event	use seat belts		
Post-event			Know local medical system

An example of the Haddon Matrix as it is applied to injury prevention strategies for overseas travelers is shown here. Persons are frequently at risk for injuries from motor vehicle crashes at home and when traveling. Hargarten has proposed the following strategies for reducing your likelihood for injury (or it's severity) when traveling. These simple strategies include understanding the environment in which you will be driving and selecting a car or vehicle that includes safety devices.

Source: Hargarten SW. International travel and motor vehicle crash deaths; the problem, risks and prevention. Travel Medicine International 106-109, 1991.

Ten Methods for Limiting Physical Energy Transfer

1. Prevent the development of energy form
2. Reduce the amount of energy
3. Prevent the energy release
4. Alter the rate of energy release from it's source or it's spatial distribution
5. Separate structures from the energy release by space or time

Haddon provided much more elaboration, though, to the role of injury intervention programs. Drawing from the Haddon Matrix and considering that the primary agent involved in injuries from motor vehicle accidents was the transfer of physical energy, Haddon proposed 10 steps to reduce the impact of this physical energy transfer, and thus, reduce injuries. These steps are outlined here. They focus primarily on altering the environment in which the energy transfer takes place and the degree to which energy can be built up.

For example, speed limits aid in reducing the degree of energy that can potentially be involved in a crash. Engineering designs and changes in the automobile can affect the time and space is which energy transfer takes place. Overall, these principles transformed injury control efforts.

Methods to limit energy transfer...

6. Place a barrier between the released energy and susceptible structures
7. Modify surfaces that can be impacted
8. Strengthen structures susceptible to damage from energy transfer
9. Prevent the extension of existing damage
10. Carry out intermediate and long-term repair and rehabilitation

Control programs to limit energy transfer (and thus reduce injuries or their severity) may be “active” or “passive”. Active programs include those in which individuals are encouraged to undertake safer practices to reduce their risk for injury. For example, wearing seat belts or motorcycle helmets.

Passive programs include those in which steps to reduce energy transfer are taken irrespective of an individual’s behavior. For example, the laws mandating air bags in cars are one form of a passive intervention. Many in the injury field prefer passive interventions because promoting changes in individual behavior has proven to be a difficult task in the past.