# Injury Epidemiology

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# Scenario 1:

- Ahmad and Lama spent their one-week vacation in a resort in Egypt with their 3-year old child (Khalid). While they were relaxing by the pool, Khalid fell in the pool. Khalid’s parents, the lifeguard and other residents tried to rescue Khalid.

# Scenario 2:

- Fatima is a 70-year old diabetic lady who is complaining of peripheral neuropathy and diabetic retinopathy (visual impairment). She was walking in her house and tripped over a loose carpet.

# Scenario 3:

- Majid was crossing the road on his way to grocery store. He was hit by a car driving on the wrong side of the road.
- He was thrown about 10 feet into the air, landed on the car and suffered a severe brain injury.

# Objectives

- Describe the concepts of injuries, why do they occur and their epidemiology
- Describe important differences between various types of injuries (intentional and unintentional)
- Understand principles of injury prevention and control
- Appreciate the burden of injury in KSA
- Apply injury epidemiology principles to road traffic accidents

# Injury

“Acute exposure to agents such as mechanical energy, heat, electricity, chemicals, and ionising radiation interacting with the body in amounts or at rates that exceed the threshold of human tolerance. In some cases, injuries result from the sudden lack of essential agents such as oxygen or heat.”

(Source: Gibson, 1961; Haddon, 1963)

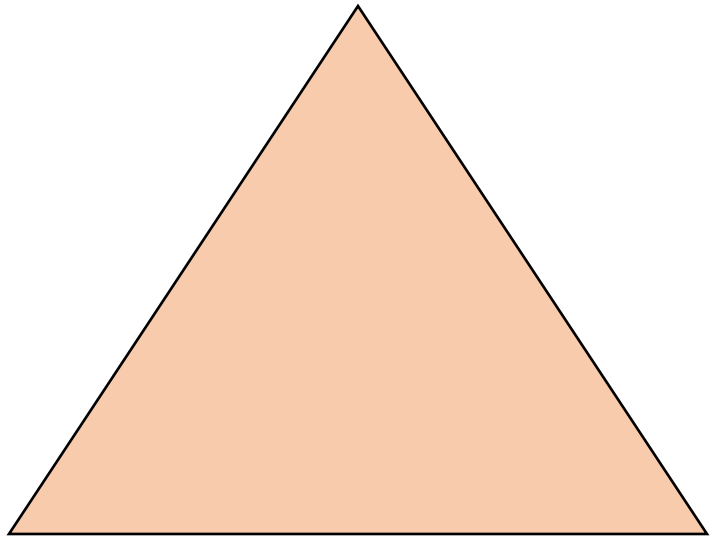
# Violence

“The intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation”

(WHO, 1996)

# Epidemiologic Triad of Injuries

Host: Human



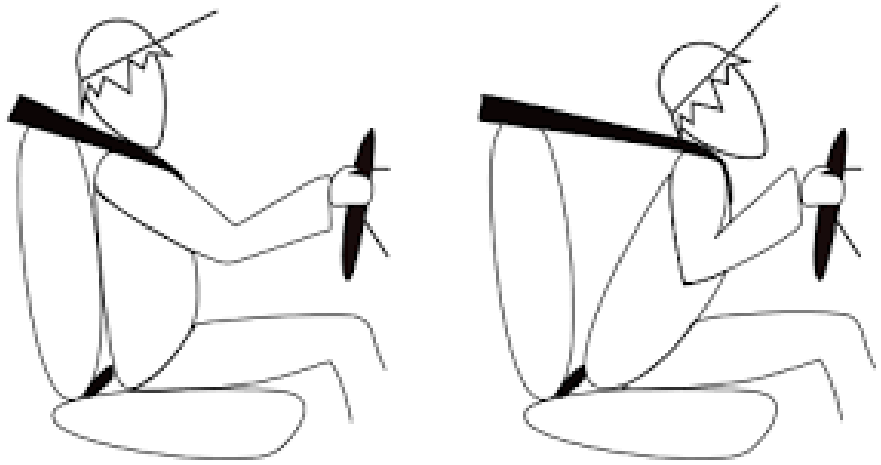
Agent: Energy

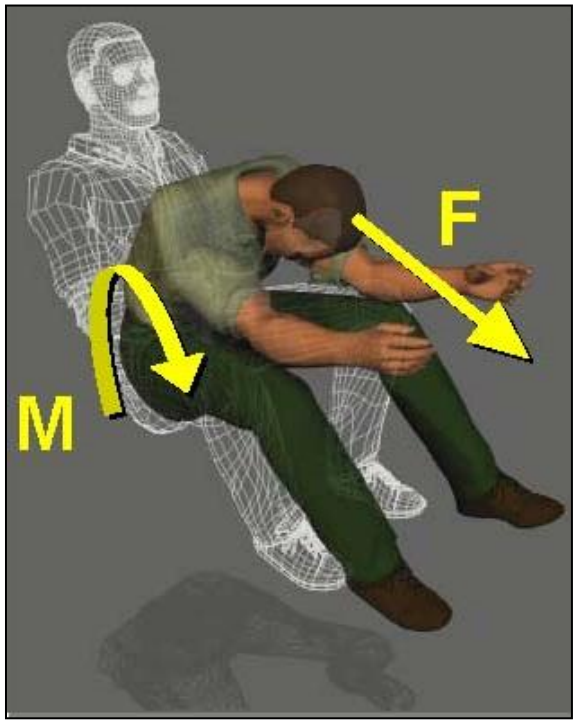
Environment: vector / vehicle that conveys the agent / energy

# Nature of Energy

- Mechanical
- Thermal / Chemical
- Electrical
- Asphyxiation

# Mechanical energy

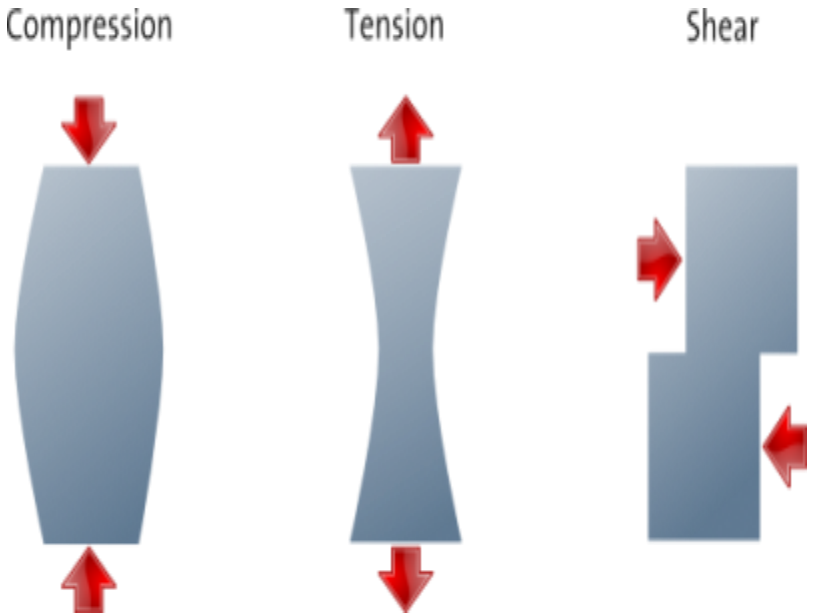





- When a vehicle stops suddenly, the occupant will continue to move at the same speed and direction

# Mechanical energy

- Stresses: contact with energy source generates forces counter to the load.
- Types:
- Tension
- Compression
- Shear



## Mechanical energy

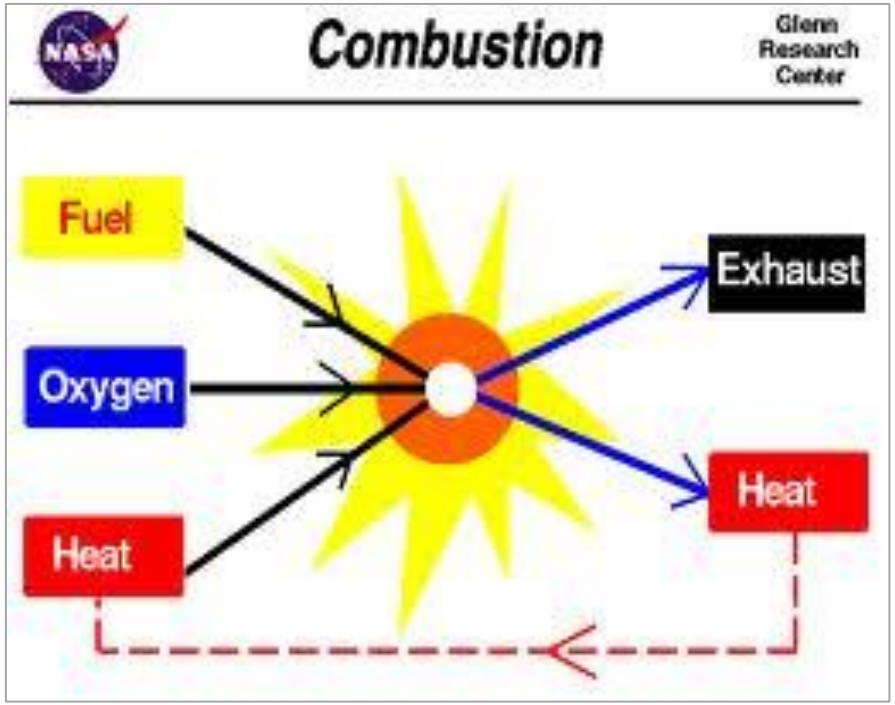
- Strain: extent of deformation, resulting from tension, compression, shear
- The shape and elasticity of the materials struck will determine the damage to the tissue.
- Devices as seat-belts, air bags and child restraints reduce the severity of injury by reducing contact with less flexible structures (second collision)

# Thermal and chemical energy

- Fires, heat & smoke
- As a result of ignition sources, flammable materials and of the heat and chemical energies

# Thermal and chemical energy

- Combustion varies by:
  - Concentration and type of heat source
  - Shape / size of a combustible
  - Oxygen concentration
  - Vaporization of gases
  - Presence or absence of catalysts

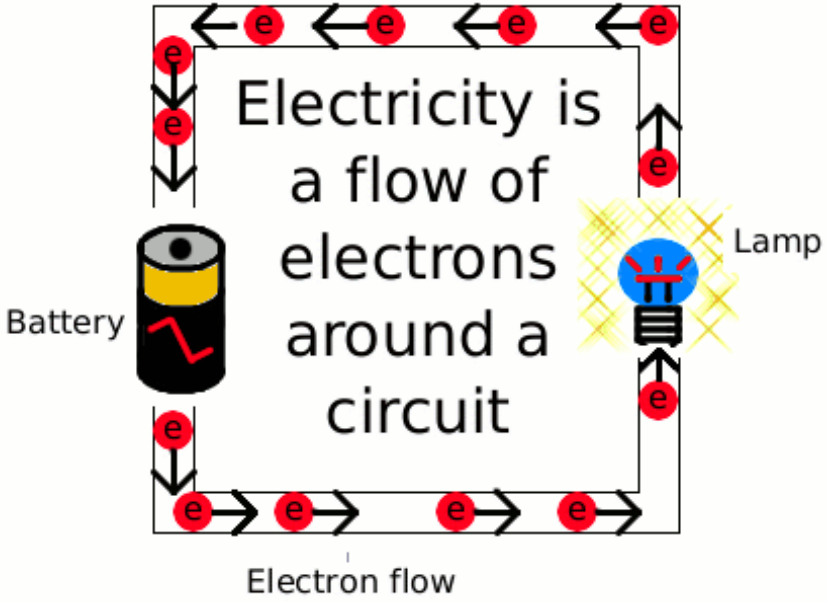


# Thermal and chemical energy

- Chemicals may be breathed / inhaled (as in a fire); ingested; injected; absorbed
- Harms of chemicals are divided into 3 phases: exposure (poisoning); toxo-kinetic (chemical's absorption through the organism's membranes: GIT, lungs' air sacs); toxo-dynamic (interaction of chemical with receptors in target tissues)

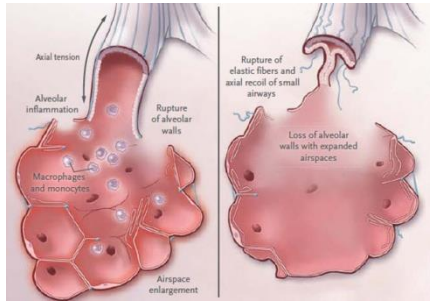
# Electrical energy

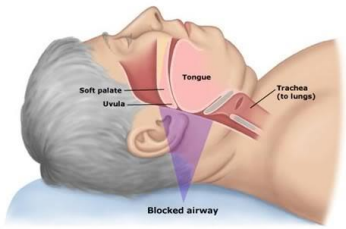
- The flow of electrons is "electrical current"
- The extent of damage of human contact with electrical energy increases with amperage.
- Skin sensitivity varies 100-fold as a function of wetness (100,000 ohms when dry; 100 ohms when wet)

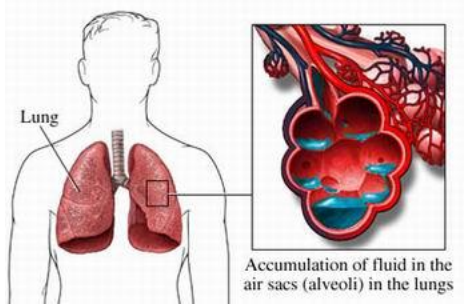


# Asphyxiation

- Asphyxiation: absence of oxygen to sustain endogenous energy conversion, which causes essential cells (in brain / heart) to be damaged within minutes
- Possible causes: objects blocking nose / mouth / trachea; mechanical blow to the trachea; constriction of the trachea; lung obstruction; water in lungs (drowning); lung congestion (endogenous fluids as in pneumonia / congestive heart failure)




# Types of Injuries

- Intentional: e.g. violence, suicide, homicide, intentional fire-arm injuries, etc
- Non-intentional (accidental): e.g. road-traffic injuries, fires, falls, poisoning, drowning-asphyxia, burns, sports, accidental fire-arm injuries, etc

# Measuring the problem of accidents

- Mortality
- Morbidity
- Disability

# Mortality

- Proportionate mortality rate
- No. of deaths per million population
- Death rate per 1000 registered vehicles per year
- number of accidents or fatalities as a ratio of no. of vehicles per km or passengers per km

# Morbidity

- In terms of :
  - Slight injuries
  - Serious injuries

# Disability

- Temporary or permanent
- Partial or total

- DALY, QALY…

# MAGNITUDE OF THE PROBLEM

**Every day,**

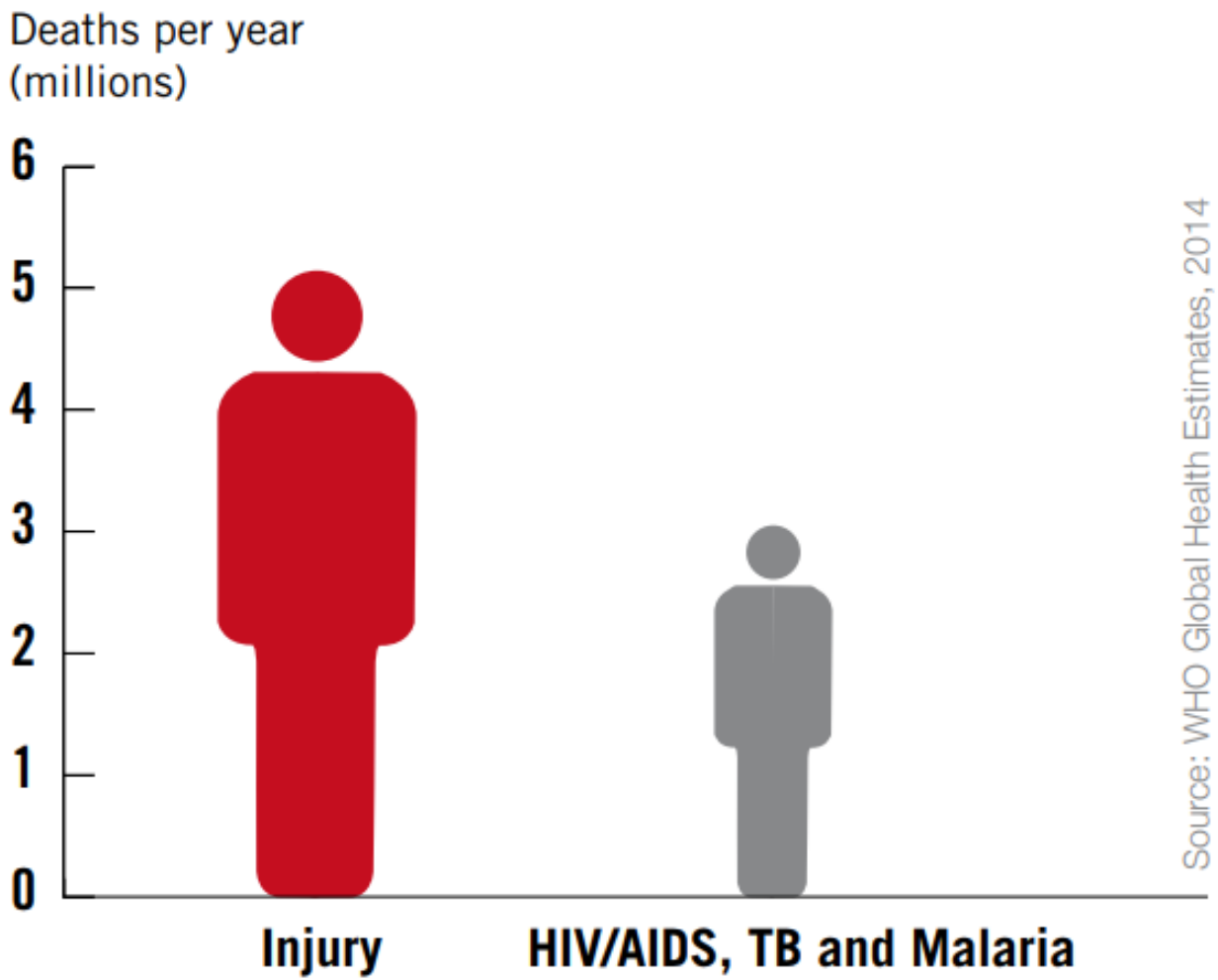
**more than 14 000 people die as a result of an injury**

**Every six seconds,**

**someone in the world dies as a result of an injury**

## The scale of the problem

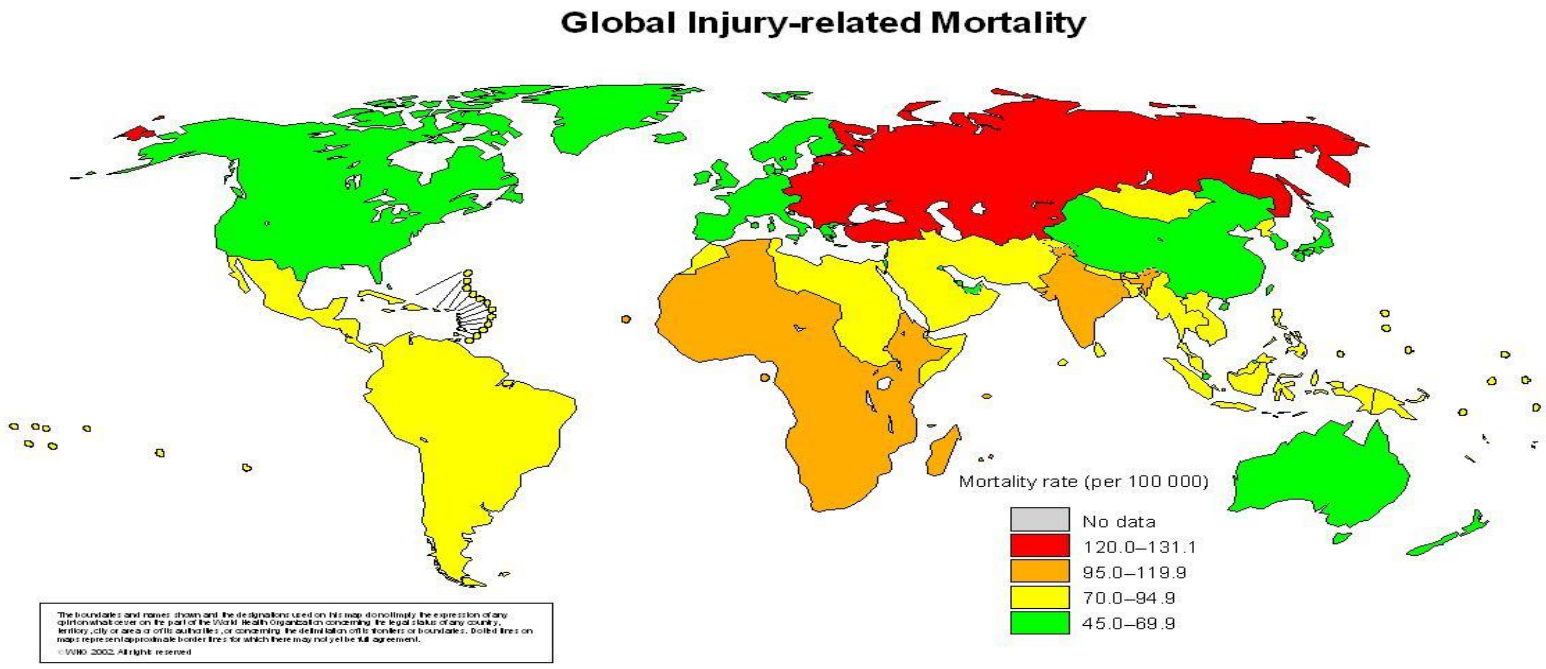
Injury deaths compared to other leading causes of mortality, world, 2012.



# Global & Regional Burden

- 12% of global burden of disease
- The most common cause of death among people 1- 44 years of age
- In Eastern Mediterranean Region, injury is a leading cause of morbidity and mortality→ loss of productive years of life and effect on health care cost
- Road traffic "**incidents**" are the leading cause of injury deaths worldwide, which strongly applies to GCC/KSA
- More than 90% of injury deaths occur in low- and middle-income countries

# Injury from a Global Perspective




**Injury-related mortality rates (per 100 000 population) in WHO regions, 2000**

| Africa | Americas | | South-East Asia | | Europe | | Eastern Mediterranean | | Western Pacific | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LMIC | HIC | LMIC | India | Other LMIC | HIC | LMIC | HIC | LMIC | HIC | China | Other LMIC |
| 118.8 | 53.8 | 76.2 | 96.9 | 75.0 | 47.6 | 131.5 | 51.1 | 70.4 | 56.2 | 51.5 | 78.4 |

HIC, High-income countries; LMIC, Low- and middle-income countries.

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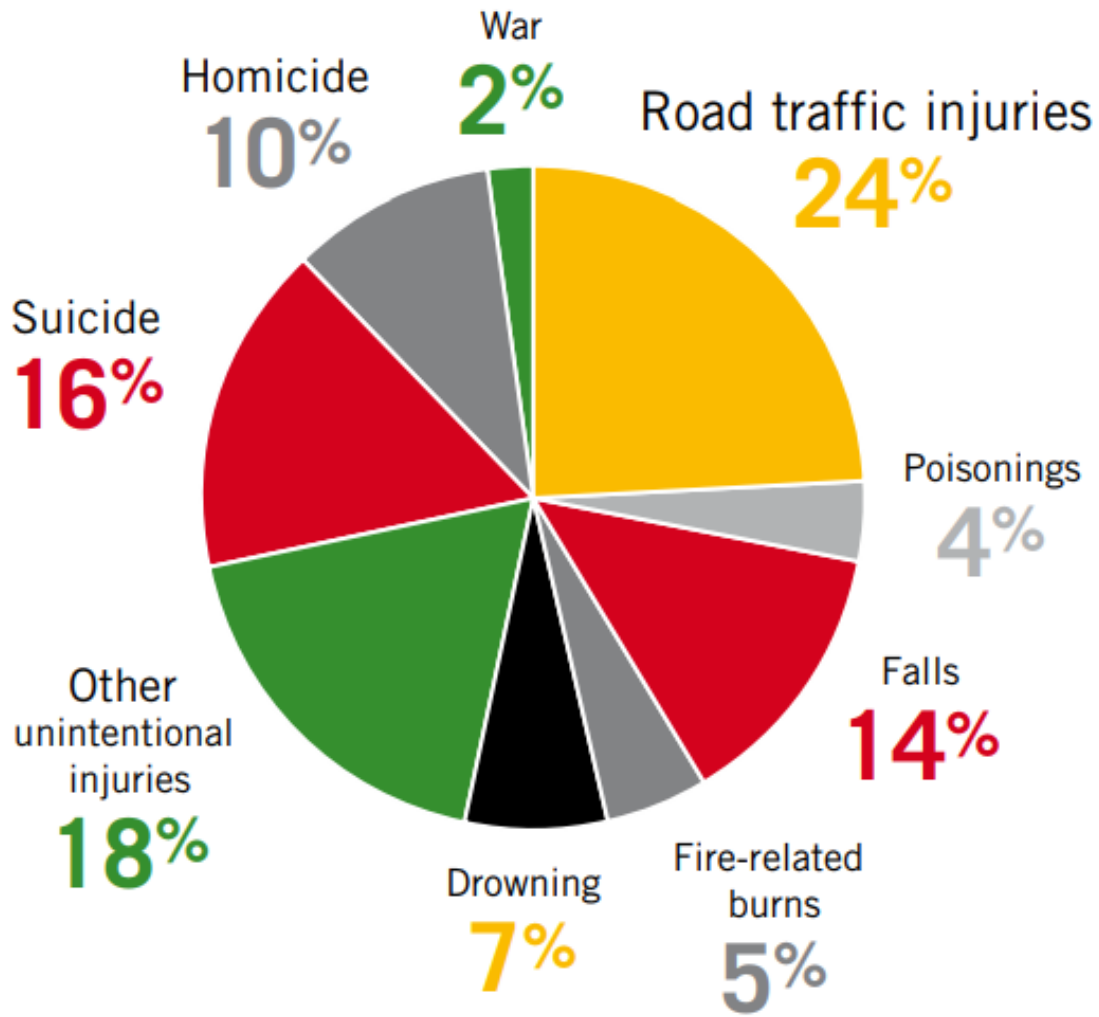
Each year > 5 million people die of injuries.

2/3 are males and the majority are young adults aged 15-44

RTA are the largest cause of injury death.

## How injuries and violence claim lives

Causes of injury deaths, world, 2012.




Source: WHO Global Health Estimates, 2014

## Injury deaths rise in rank

Leading causes of death, 2012 and 2030 compared.

| Total 2012 | |
|---|---|
| 1 | Ischaemic heart disease |
| 2 | Stroke |
| 3 | Chronic obstructive pulmonary disease |
| 4 | Lower respiratory infections |
| 5 | Trachea, bronchus, lung cancers |
| 6 | HIV/AIDS |
| 7 | Diarrhoeal diseases |
| 8 | Diabetes mellitus |
| 9 | Road traffic injuries |
| 10 | Hypertensive heart disease |
| 11 | Preterm birth complications |
| 12 | Cirrhosis of the liver |
| 13 | Tuberculosis |
| 14 | Kidney diseases |
| 15 | Suicide |
| 16 | Birth asphyxia and birth trauma |
| 17 | Liver cancer |
| 18 | Stomach cancer |
| 19 | Colon and rectum cancers |
| 20 | Alzheimer's disease and other dementias |
| 21 | Falls |

| Total 2030 | |
|---|---|
| 1 | Ischaemic heart disease |
| 2 | Stroke |
| 3 | Chronic obstructive pulmonary disease |
| 4 | Lower respiratory infections |
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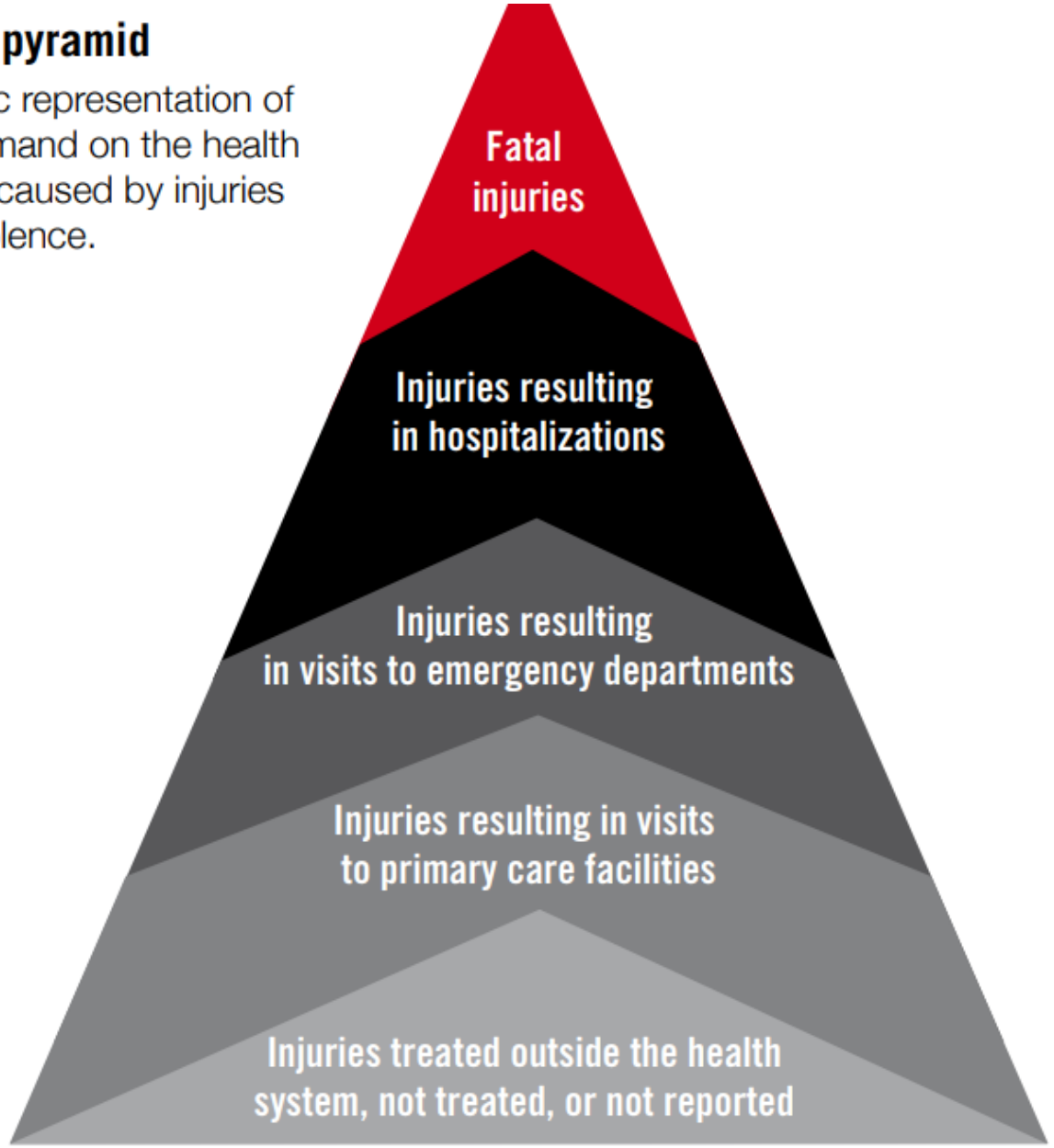
| 14 | Stomach cancer |
| 15 | Colon and rectum cancer |
| 16 | Suicide |
| 17 | Falls |
| 18 | Alzheimer's disease and other dementias |
| 19 | Preterm birth complications |
| 20 | Breast cancer |
| 21 | Endocrine, blood, immune disorders |

Source: WHO Global Health Estimates, 2014. www.who.int/healthinfo/global_burden_disease/projections/en/index.html

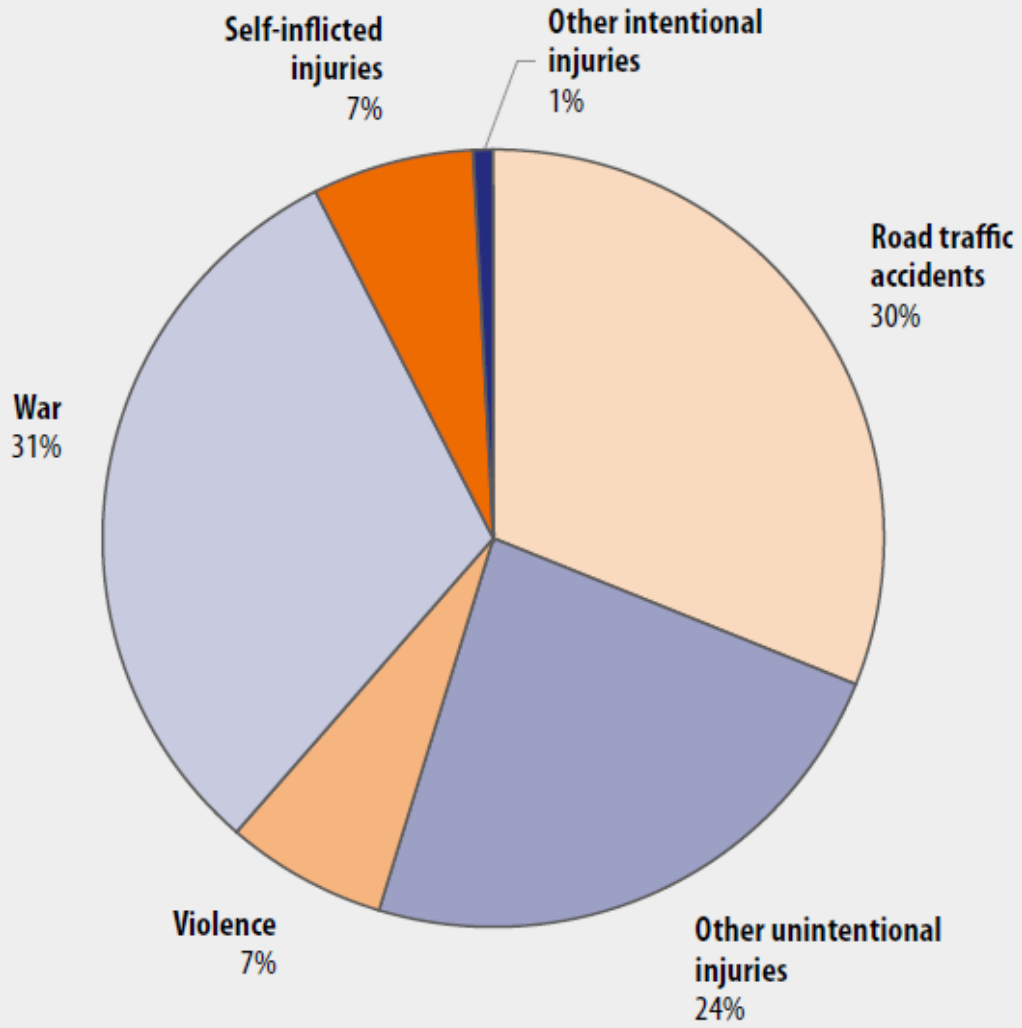
## Injury pyramid

Graphic representation of the demand on the health sector caused by injuries and violence.

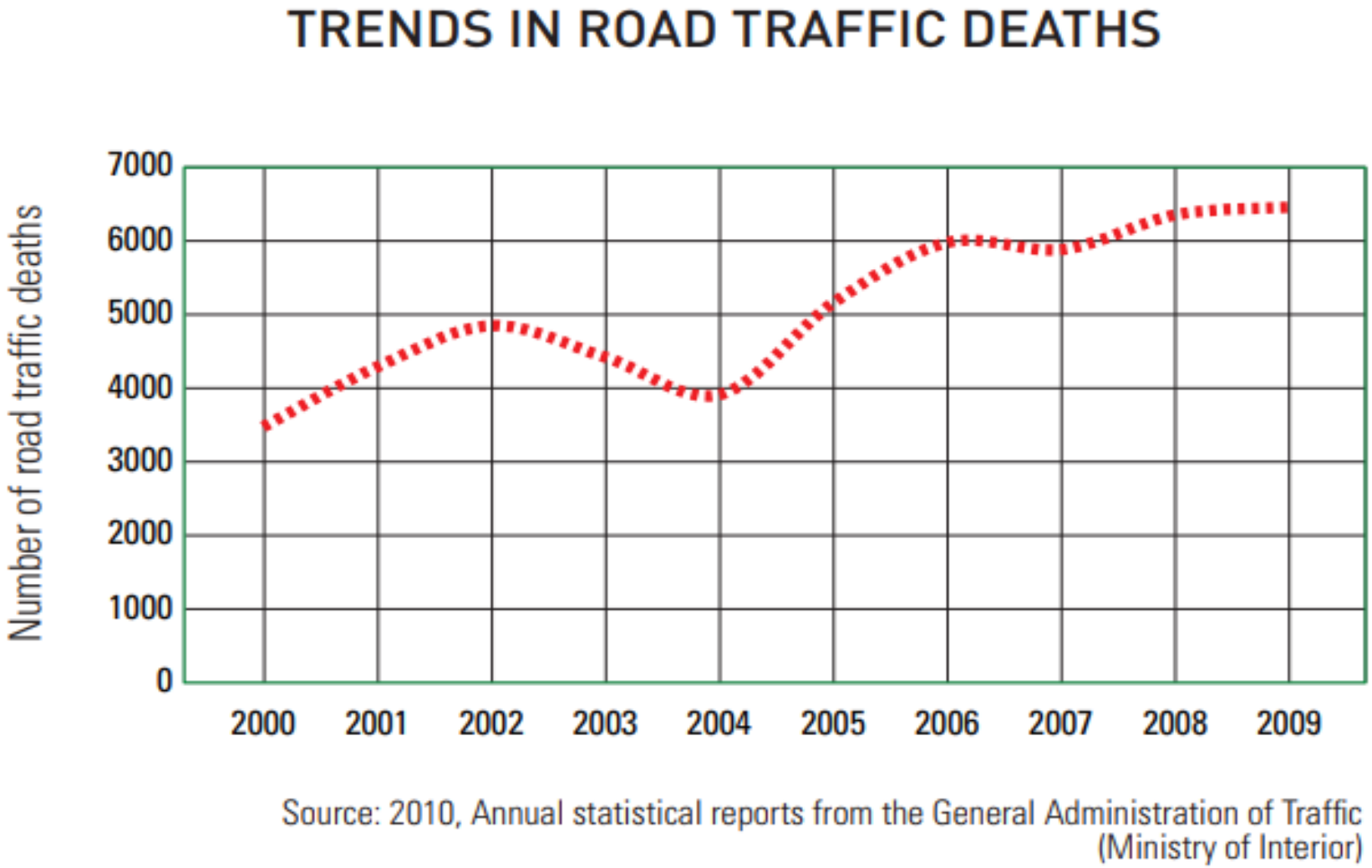



Source: WHO, 2014

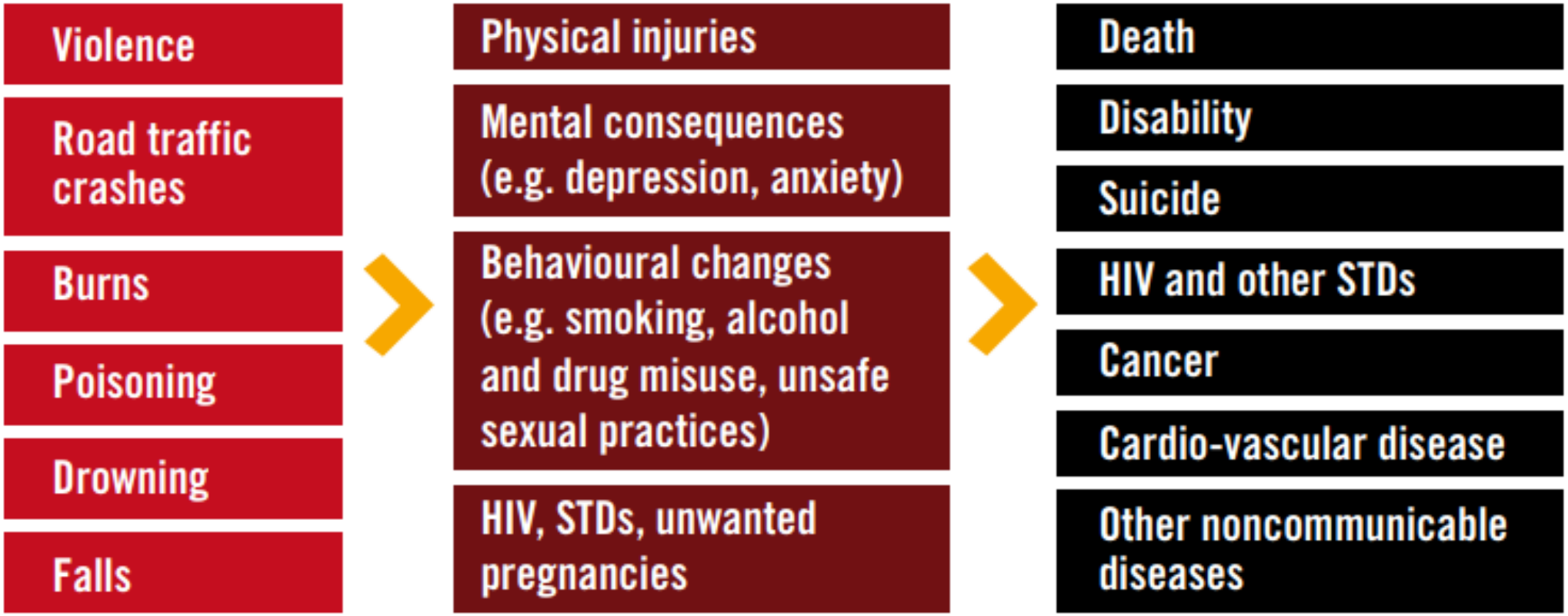
Figure 10: Causes of injury deaths among men aged 15–59 years, Eastern Mediterranean Region, 2004



# Saudi Arabia – RTA death numbers



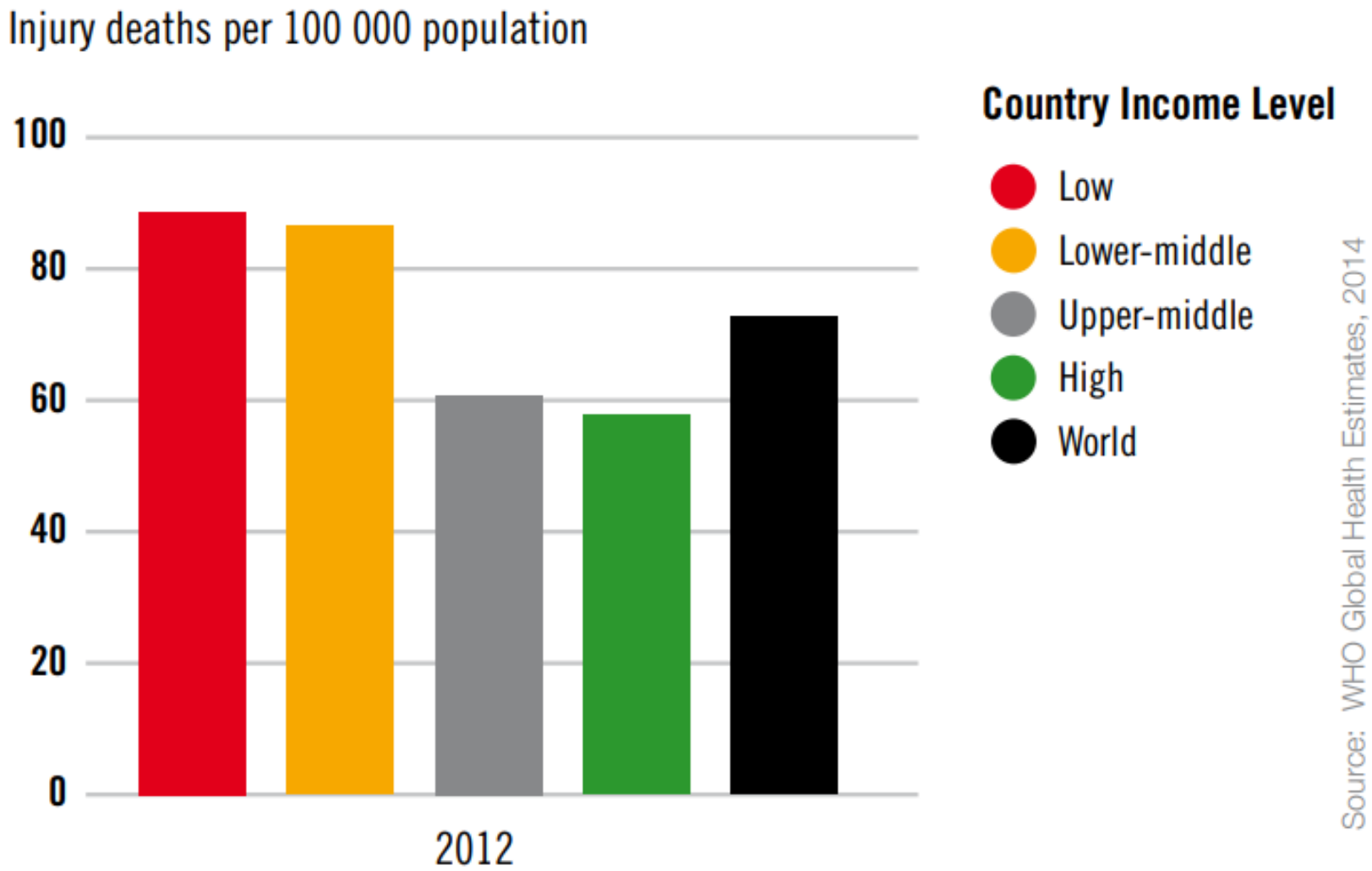
# Consequences of injuries and violence




Source: WHO, 2014

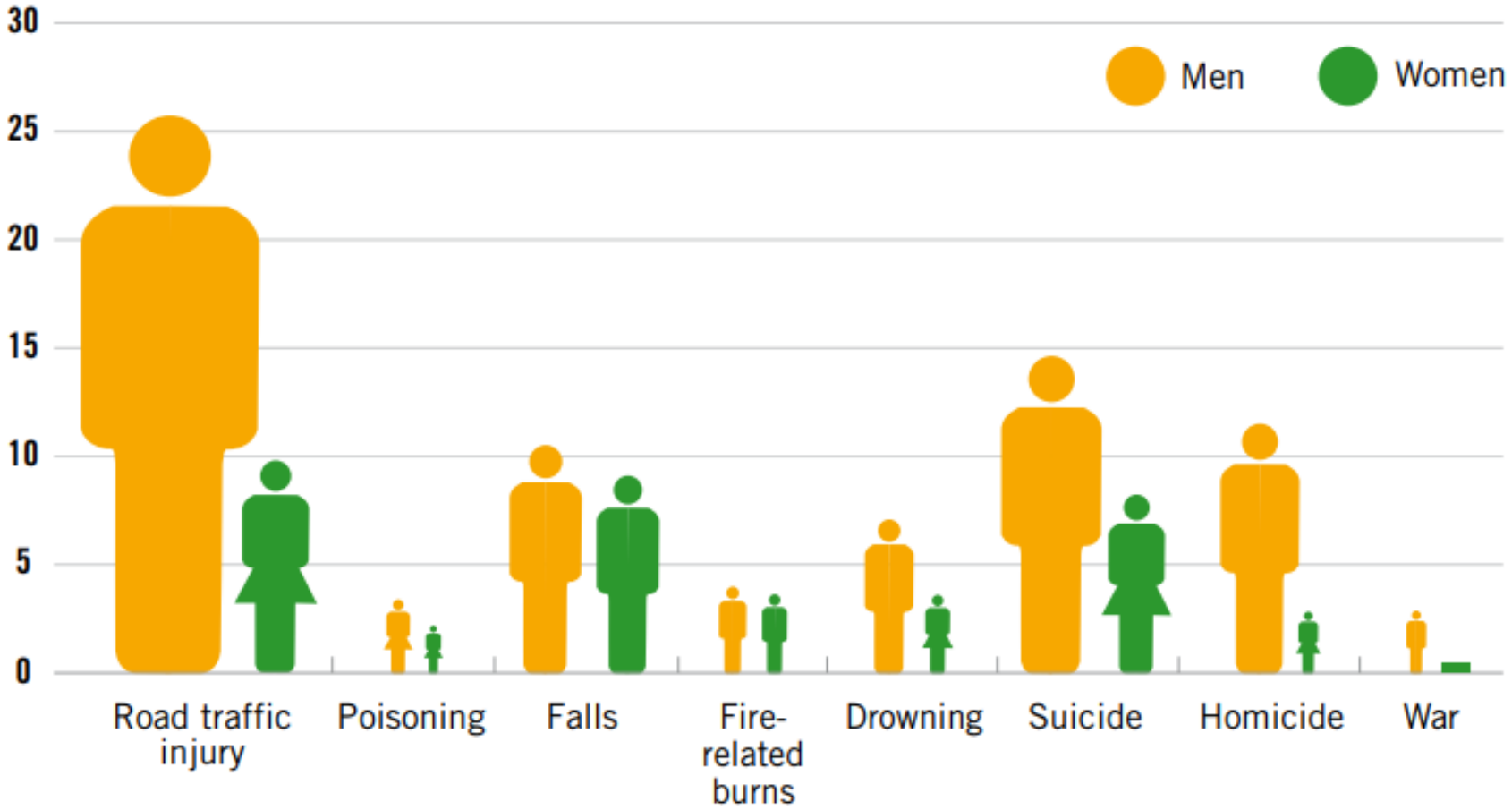
## Poorer countries are worst-affected by injuries and violence

Injury death rates by country income level, world, 2012.



## Men are more at risk of death from injuries and violence

Death rates per 100 000 population, by cause of injury and sex, world, 2012.




Source: WHO Global Health Estimates, 2014

# Haddon Phase-Factor Matrix

| Phase | Host (Human) | Vector (Vehicle) | Physical Environment | Cultural Environment |
|---|---|---|---|---|
| **Pre-Event** | | | | |
| **Event** | | | | |
| **Post-Event** | | | | |

# Haddon Phase-Factor Matrix

## Motor vehicle crash

| Phase | Host (Human) | Vector (Vehicle) | Physical Environment | Cultural Environment |
|---|---|---|---|---|
| **Pre-Event** | Alcohol Experience<br>Judgment | Brake status<br>Tires | Nigh,<br>Rain<br>Icy road | Acceptance of Drinking and Driving |
| **Event** | No seat belt | No air bag<br>Hardness of surfaces | Tree too close to road,<br>No guard rail | Speed limits<br>Enforcement of seat belt |
| **Post-Event** | Physical condition | Fuel system integrity<br>Cell Phone | Distance of emergency response | Support for Trauma systems,<br>EMS standard |

# Types of Data & Potential Sources of Information

## Mortality

- Death certificates
- Reports from mortuaries

## Morbidity and Health-related

- Hospitals
- Medical records


## Self Reported

- Surveys
- Media

## Community-based

- Demographic records
- Local government  records

## Law enforcement

- Police records
- Prison records

## Economic-social

- Institutional or agency records
- Special studies

Source: adapted from Krug et al., eds., 2002

# PREVENTION & CONTROL

# Prevention

- **Primary prevention:**

Raising awareness of the community, at its different levels, as to methods of avoiding injuries. This includes health promotion / health education activities and applying preventive measures accordingly

- **Secondary prevention:**

Early detection, proper evaluation and management of injuries at different levels of healthcare delivery (primary, secondary and tertiary facilities)

- **Tertiary prevention:**

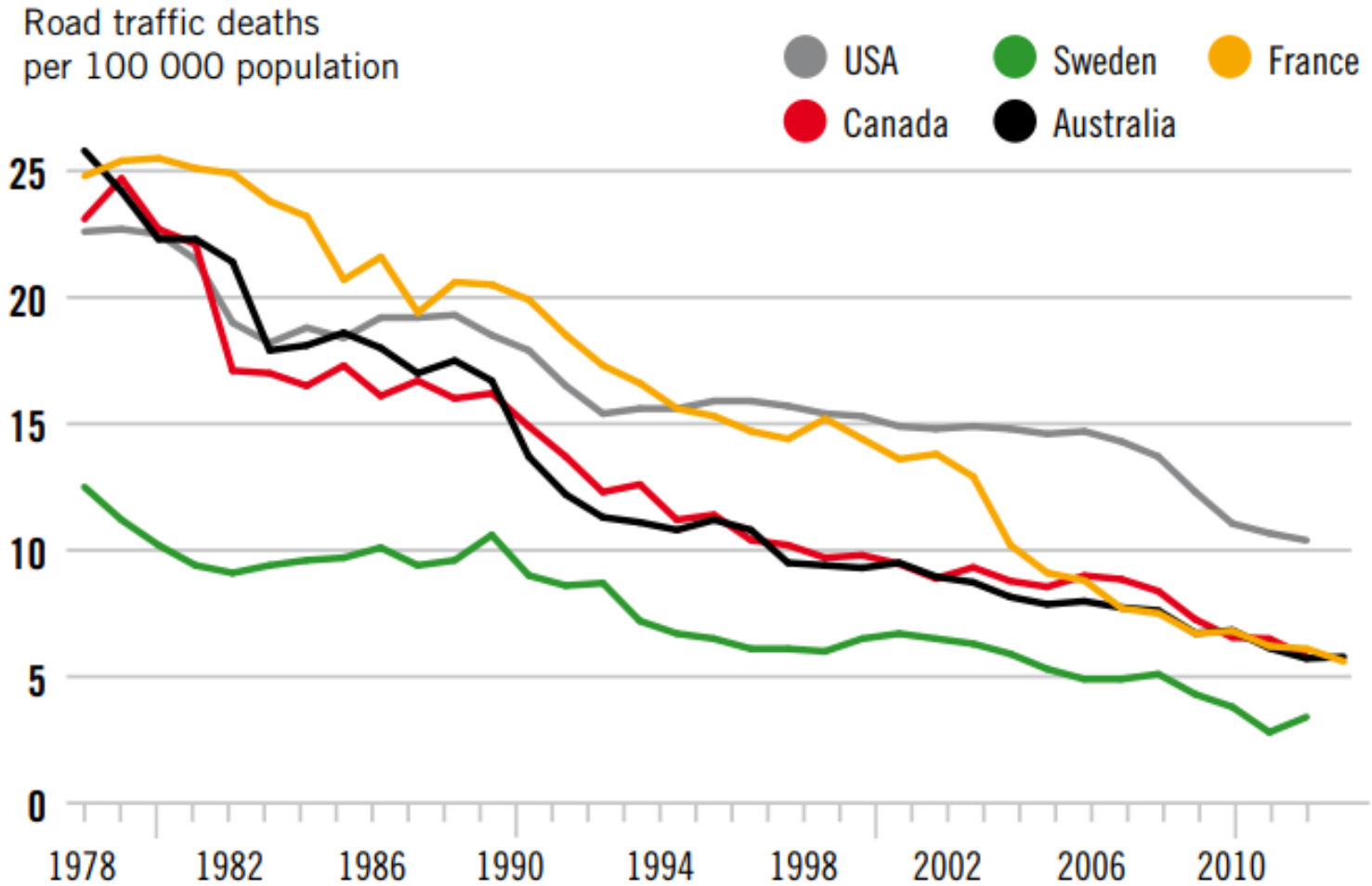
Management of complications of injuries, especially disabilities, including rehabilitative measures and approaches, improvement of quality of life of injury victims, as well as palliative care, when needed

# Prevention

- Safety education
- Promotion of safety measures
- Primary care
- Elimination of causative factors
- Low enforcement
- Rehabilitation
- Research and data collection

## Rich countries reduce road traffic deaths

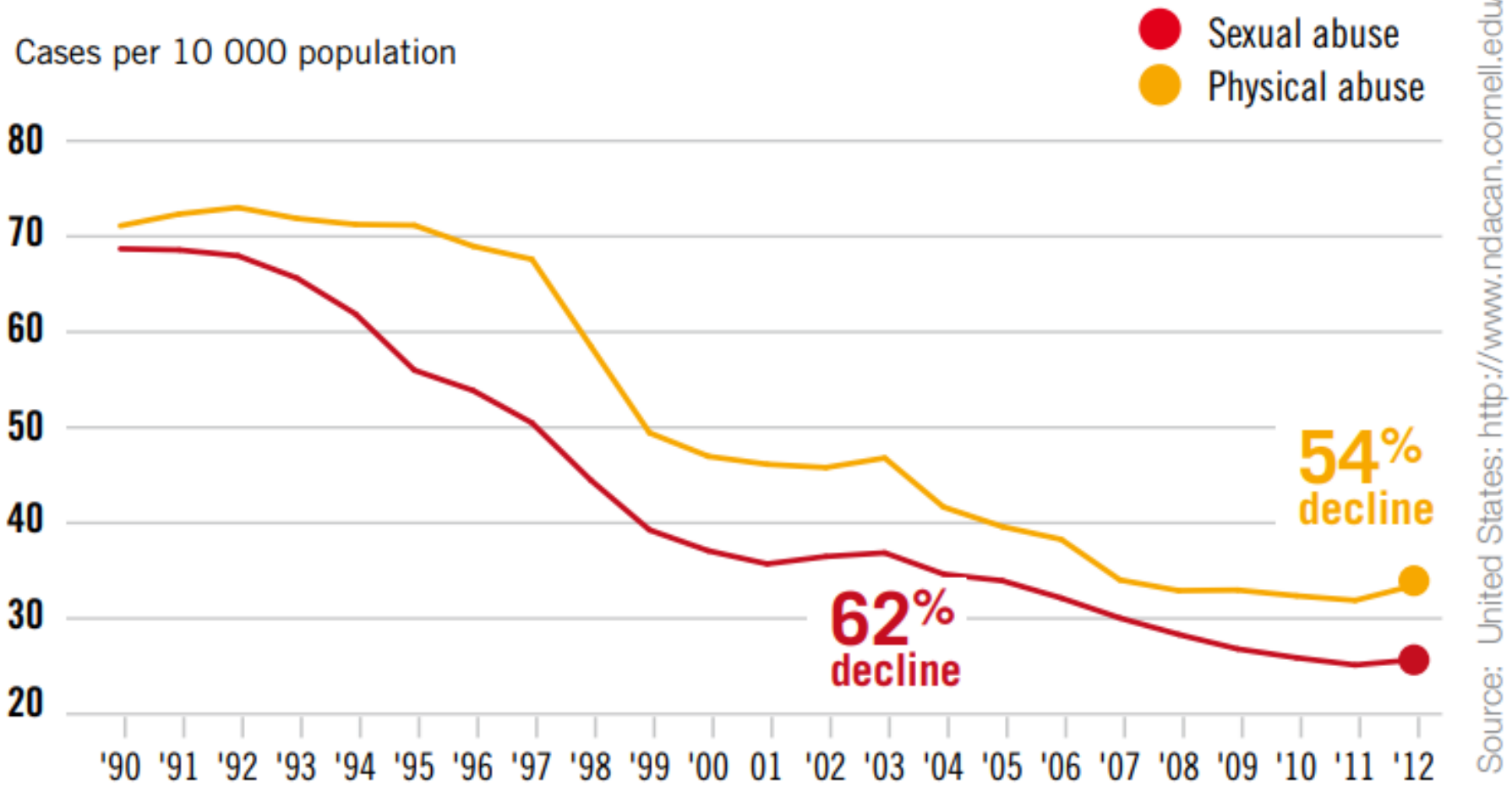
Reported trends in road traffic deaths in selected high-income countries.




Sources: Australia: http://tinyurl.com/mu3xk87
Canada: http://tinyurl.com/n7kv7dl
France: http://tinyurl.com/k26cnah
Sweden: http://tinyurl.com/qcjc7vf
United States: http://tinyurl.com/42tb7ja

## United States reduces child abuse

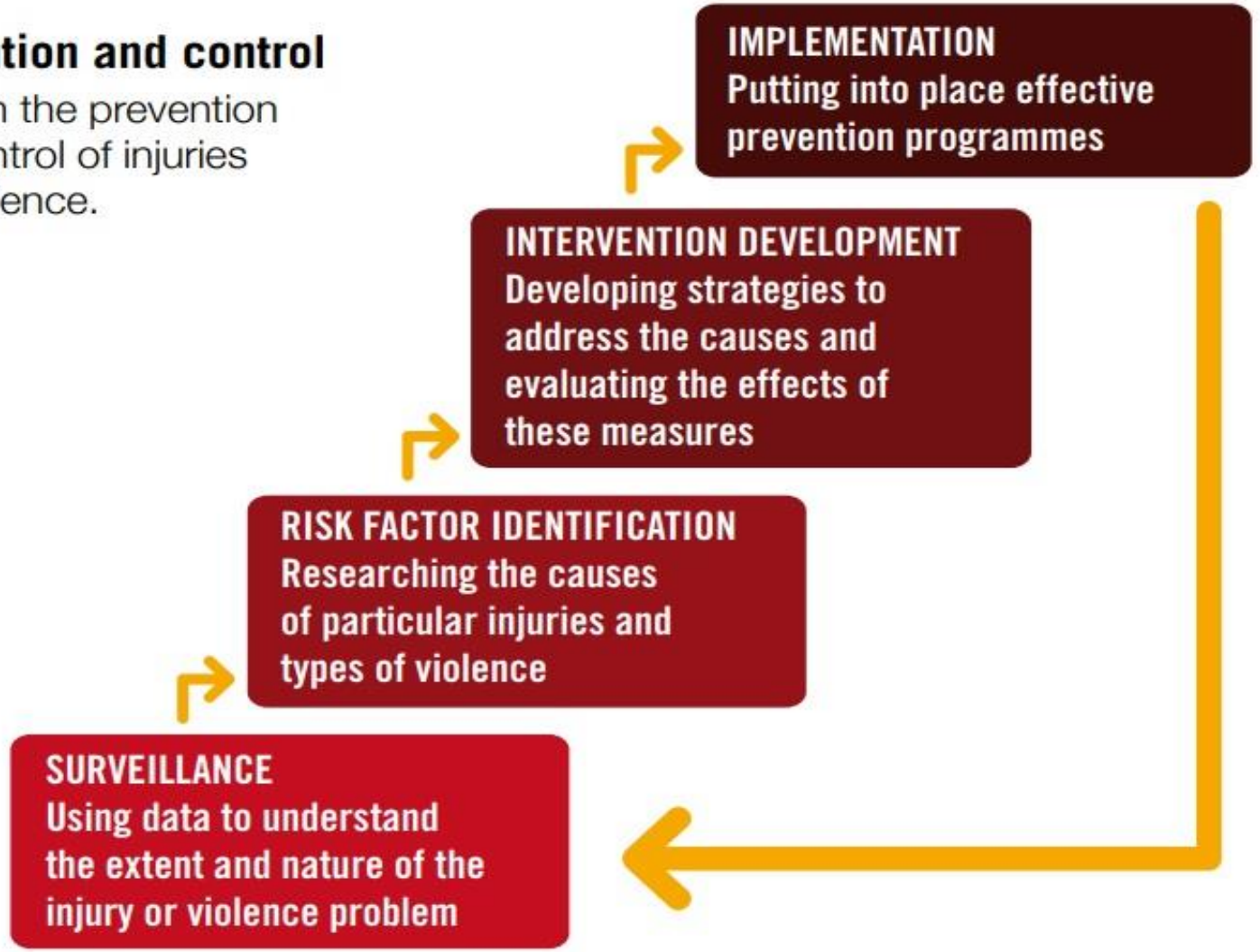
Trends in child sexual and physical abuse in the USA.




Source: United States: http://www.ndacan.cornell.edu/

## Prevention and control

Steps in the prevention and control of injuries and violence.




Source:WHO, 2014

# Measures - Road traffic crashes


- Setting and enforcing laws (speeding, drinking and driving, motorcycle helmets, seat-belts, child restraints)
- Developing safer roadway infrastructure, including engineering measures to reduce speeds in urban areas and separate different types of road users
- Implementing vehicle and safety equipment standards
- Setting and enforcing laws on daytime running lights for motorcycles
- Introducing a graduated driver licensing system for novice drivers

Source: WHO, 2014

# Measures - Burns

- Setting and enforcing laws on smoke detectors
- Setting and enforcing laws on hot tap water temperatures
- Developing and implementing a standard for child-resistant lighters
- Treating burns patients in a dedicated burns center

Source: WHO, 2014

# Measures - Drowning

- Installing barriers controlling access to water
- Providing capable child care for pre-school children in safe places away

from water

- Teaching school-age children basic swimming, water safety

and safe rescue skills

- Training bystanders in safe rescue and resuscitation
- Wearing of personal flotation devices


Source: WHO, 2014

# Measures - Falls

- Setting and enforcing laws requiring window guards for tall buildings
- Redesigning furniture and other products
- Establishing standards for playground equipment

Source: WHO, 2014

# Measures - Poisoning

- Setting and enforcing laws for child resistant packaging of medicines and poisons
- Removing toxic products
- Packaging drugs in non-lethal quantities
- Establishing poison-control centers


Source: WHO, 2014

# Measures – Interpersonal violence

- Developing safe, stable and nurturing relationships between children and their parents or caregivers
- Developing life skills in children and adolescents
- Reducing the availability and harmful use of alcohol
- Reducing access to guns and knives
- Changing cultural and social norms that support violence
- Reducing violence through victim identification, care and support programs


Source: WHO, 2014

# Measures - Suicide

- Reducing access to common means, such as firearms, pesticides and certain medications
- Implementing policies and interventions to reduce the harmful use of alcohol
- Ensuring early detection and effective treatment of mental disorders, particularly depression and alcohol use disorders
- Ensuring management of people who have attempted suicide or are at risk, including assessment and appropriate follow-up
- Training primary health care workers and other ‘gatekeepers’ who are likely to interact with people at risk of suicide
- Adoption of responsible reporting of suicide by the media

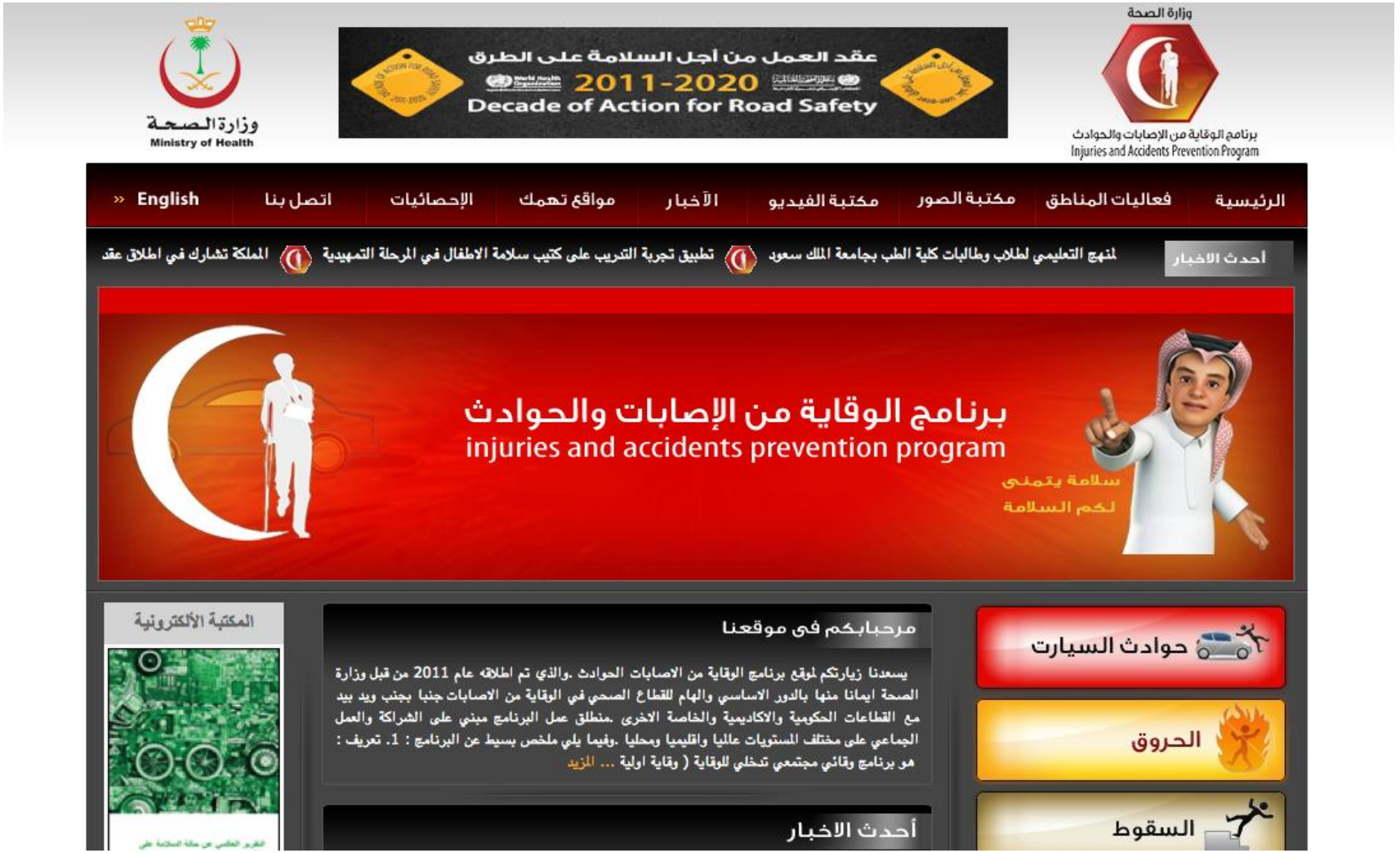
Source: WHO, 2014

# Proven Injury Prevention Interventions

- Car safety seats and belts
- Air bags
- Motorcycle helmets
- Bicycle helmets
- Child resistant packaging
- Swimming pool fencing
- Smoke detectors
- Self extinguishing cigarettes


# KSA EFFORTS

# http://moh-ncd.gov.sa/injury/index.php




- Surveillance System
- Education
- Capacity Building


# Application to Road Traffic Accidents

# Application to RTI

- Host: victim: e.g. driver, passenger, pedestrian, etc
- Agent: mechanical / thermal energy
- Environment: vehicle(s) of incident

# Application to RTI

- If a person must stop suddenly, as in a crash of a vehicle, that energy must be dissipated in the vehicle, environment, or individual's tissues
- When the vehicle stops, the occupant will continue to move at the pre-crash speed into interior structures, or into the materials in the exterior environment if ejected.
- Stresses: contact with energy source generates forces counter to the load. Types: tension (pulling molecules apart), compression (pushing molecules together), shear (from a tangential force)

# Application to RTI

- Strain: extent of deformation, resulting from tension, compression, shear
- The shape and elasticity of the materials struck will determine the damage to the tissue.
- Devices as seat-belts, air bags and child restraints reduce the severity of injury by reducing contact with less flexible structures (second collision)

# Application to RTI

- **Primary prevention:**

Raising awareness of the community, at its different levels, as to methods of avoiding RTI. This includes legislations, health promotion activities and applying preventive measures (seat-belts, child restraints, air-bags, good roads, following traffic rules, etc)

- **Secondary prevention:**

Early detection, proper evaluation and management of RTI at different levels of healthcare delivery (especially tertiary facilities: e.g. emergency / trauma facilities and related services)

- **Tertiary prevention:**

Management of complications of RTI, especially disabilities, on medical / social / economic levels, including rehabilitative and physiotherapy measures

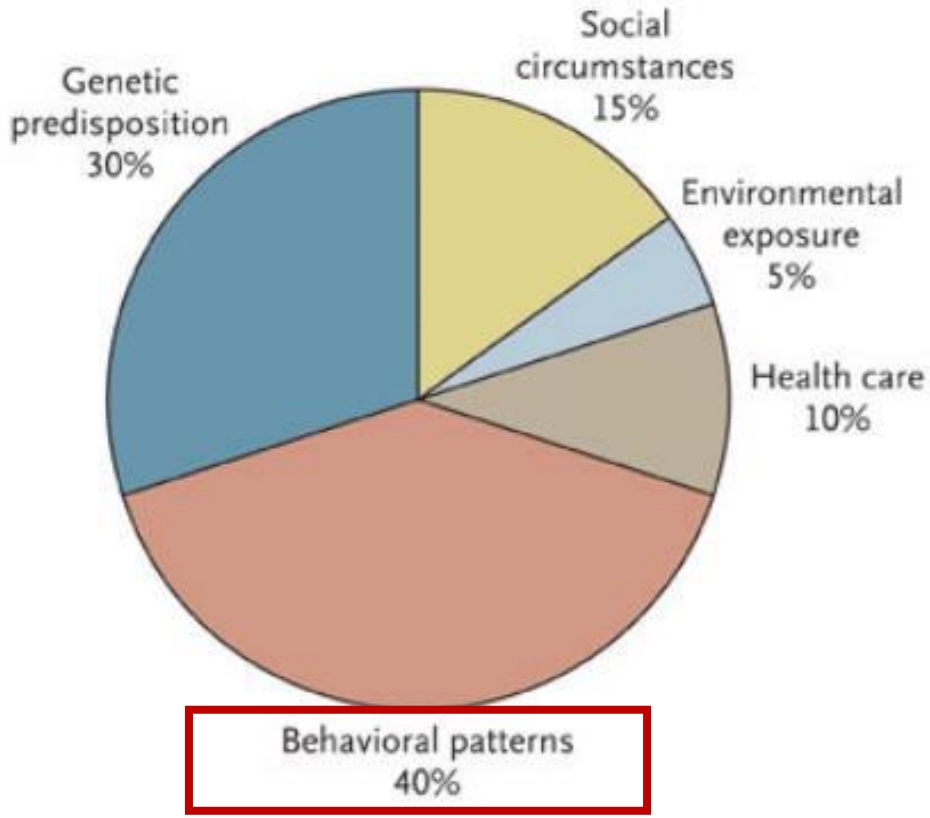
# National strategic plan to reduce RTI:

- National strategic plan that covers the 4Es:
- Education: annual traffic weeks.
  - Saudi Society Organization for Traffic Safety

  http://www.salamh.org.sa
- Engineering: road infrastructure and vehicles
- Enforcement: seatbelt rule, speed limit law
- Emergency: Saudi Red Crescent Society (SRCS)

- Epidemiology

# Proportional Contribution to Premature Death

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