



Child and vulnerable person tolerance and system requirements

Professor Julie Brown, The George Institute for Global Health

Building on Session 1

Today

- What makes children and other groups **vulnerable**
- What this means for system design



What do we mean by vulnerability?

- Vulnerable road user types: Pedestrians, cyclists & motorcyclists
- Vulnerable road users:
 - Children and young people
 - Older people
 - People living with disability
 - Other at higher risk groups

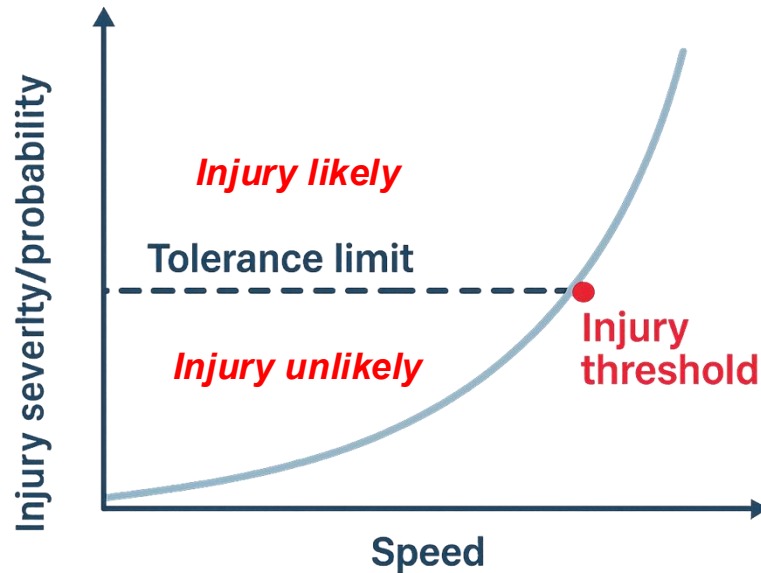


Understanding vulnerability



Injury = Energy > Tolerance

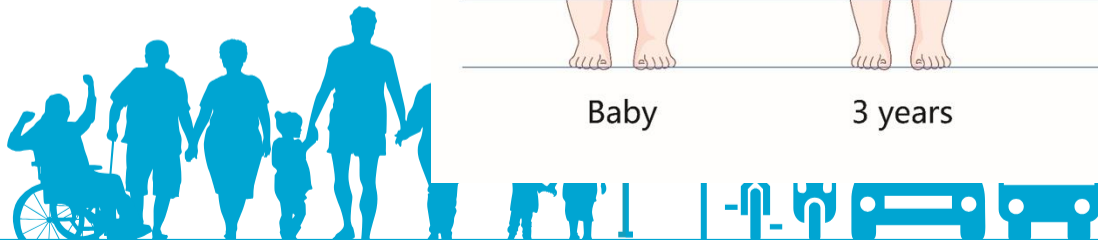
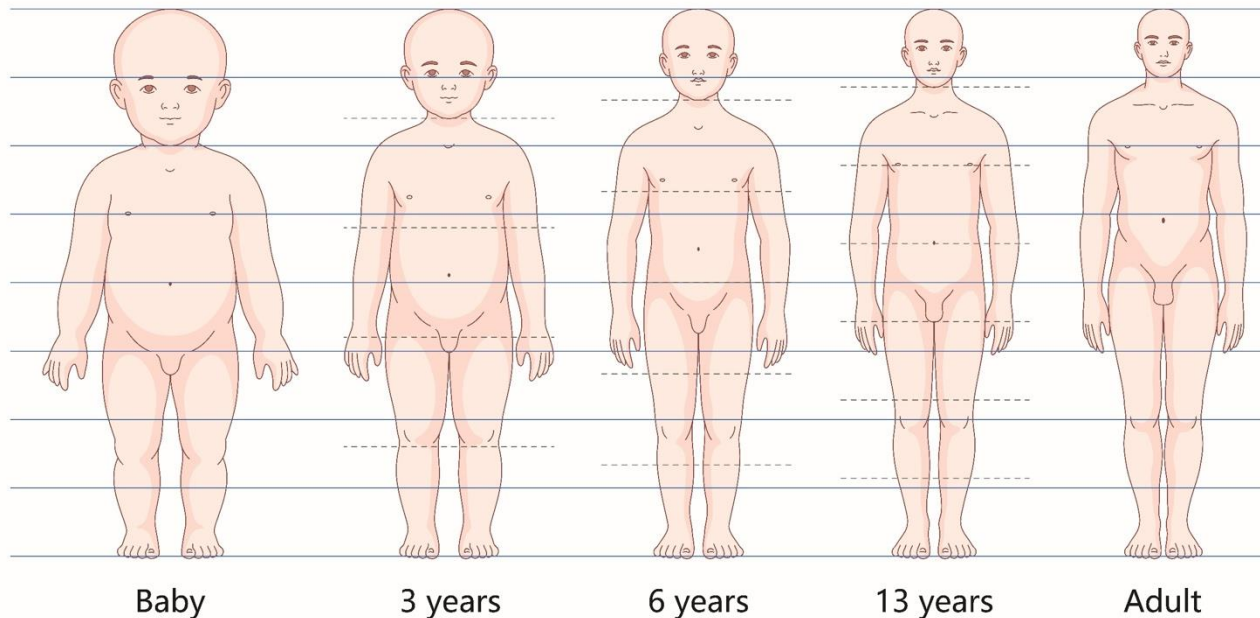
Energy results from speed, mass and impact



Children are not small adults

Changes In Body Proportions With Age

Systems
designed for
adults do not
adequately
protect
children



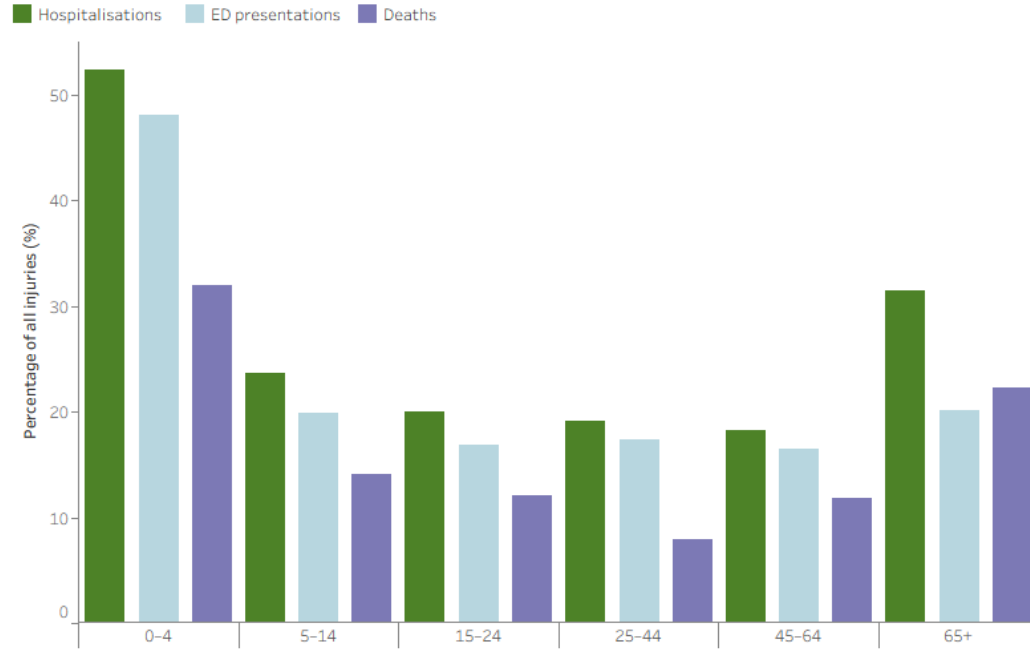
Children are not small adults

e.g. Head injuries as a share of all injuries

- Larger head → ↑ head impact
- Thinner skull → ↓ protection
- Flexible rib cage → ↑ internal force
- Developing brain → ↑ vulnerability



Different injury patterns

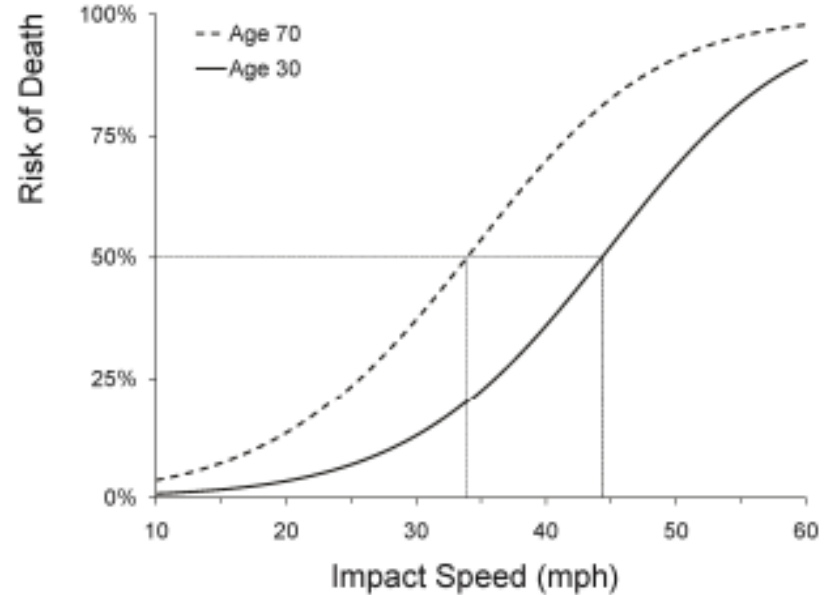


Sources: AIHW National Hospital Morbidity Database, AIHW Non-Admitted Patient Emergency Department Care Database, AIHW National Mortality Database.
<https://www.aihw.gov.au/>

Older adults & frailty

- Bone density $\downarrow \rightarrow \uparrow$ fracture risk
- Tissue fragility $\uparrow \rightarrow \downarrow$ impact tolerance
- Physiological reserve $\downarrow \rightarrow \downarrow$ recovery

Older adults experience greater injury severity and poorer outcomes from the same crash forces, due to frailty and reduced physiological reserve



Tefft BC. *Impact speed and a pedestrian's risk of severe injury or death*. AAA Foundation for Traffic Safety, 2011



There is no 'standard' road user

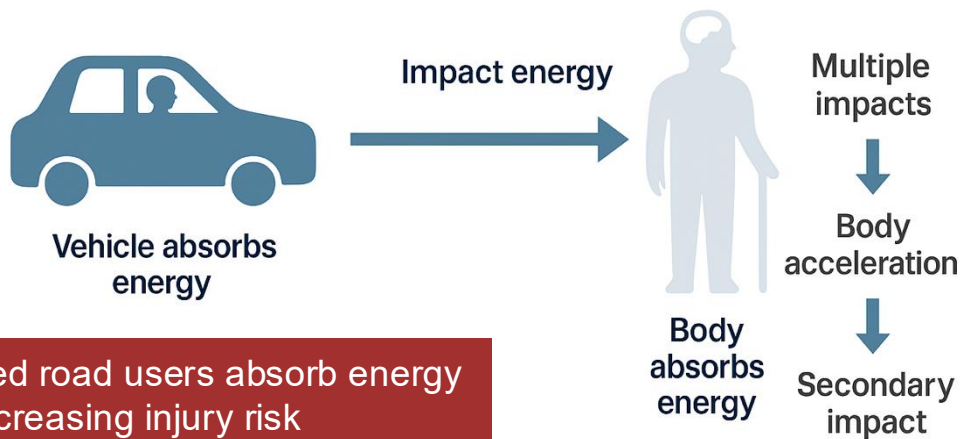
- Age and sex
- Body size, shape and posture
- Disability and mobility
- How people interact with the environment

Systems designed for a 'standard user' can expose people to avoidable harm



Exposure matters

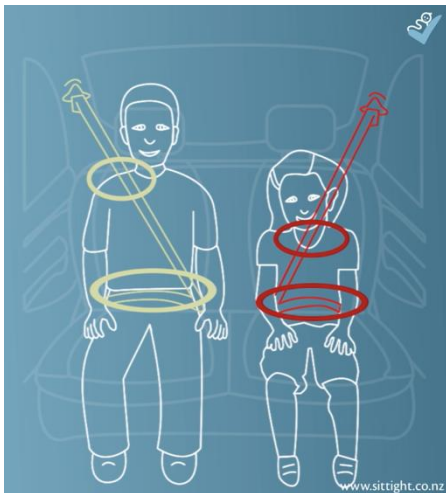
Exposure determines how energy is transferred



Unprotected road users absorb energy directly, increasing injury risk



When systems don't fit people



Seatbelts designed for adults



Crossings designed for 'average' users



If systems don't fit people, they don't provide good protection

Vulnerability is the mismatch between people and the system

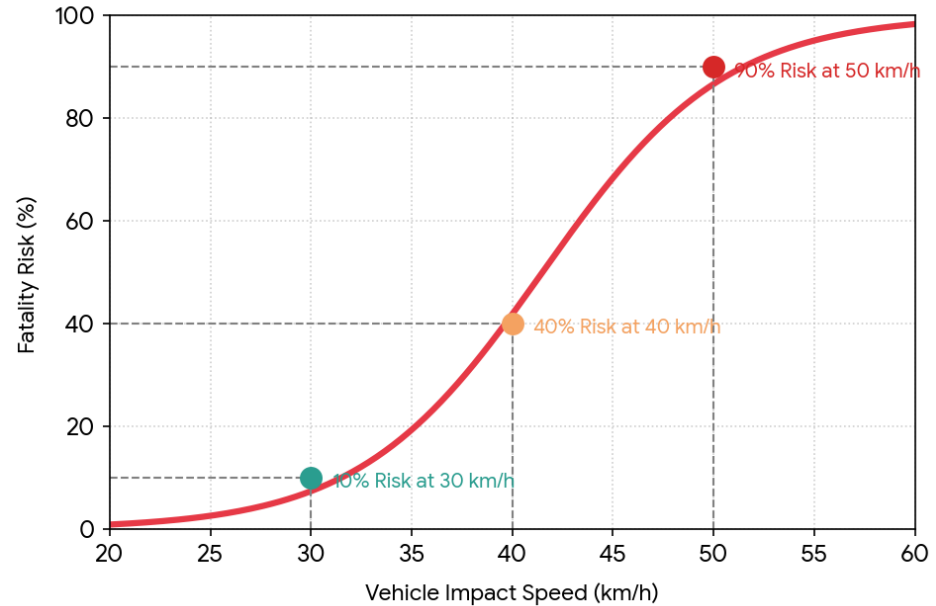


Speed determines whether a crash is survivable

- Speed determines energy & forces
- Survival drops sharply > 30km/h
- Lower speeds particularly important for children & vulnerable groups

Lower tolerance →→ Lower thresholds

Pedestrian Fatality Risk vs. Vehicle Impact Speed



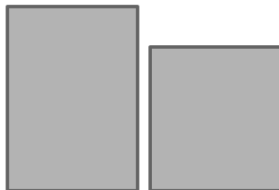
Why small changes in speed matter

1x ENERGY



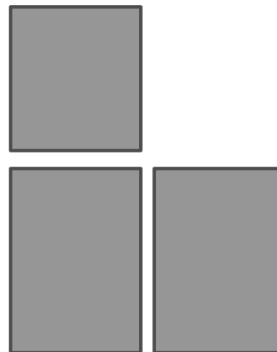
30 km/h

approx. 2x ENERGY



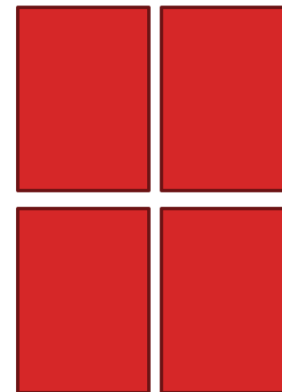
40 km/h

approx. 3x ENERGY



50 km/h

4x ENERGY



60 km/h

Small increases in speed create
much larger crash forces



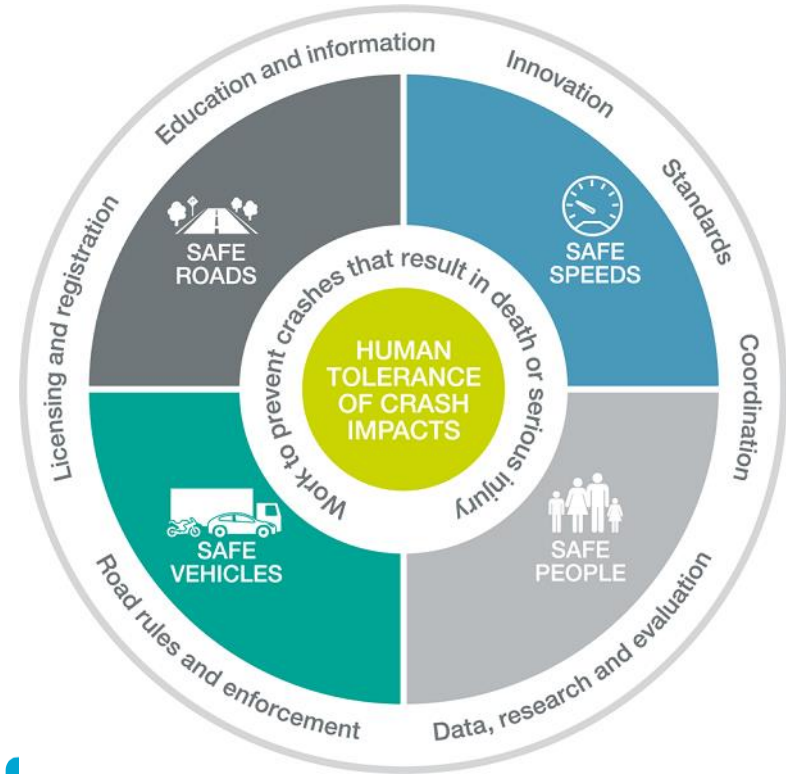
Where systems fail

- High speeds + vulnerable road users
- Mixed traffic environments
- Lack of safe crossings
- Inequitable access to safe infrastructure



Designing for Human Limits

- Safe speeds
- Safe roads
- Safe vehicles



Source: Australian Road Safety Strategy

Designing for protection



Safety works best if it fits the person using it



**If a transport system is safe for children
and the most vulnerable, it will be safer for
everyone**



Key takeaways

- Vulnerability is shaped by the interaction between: tolerance, exposure, and system design
- Human tolerance is limited – and varies across people
- Risk is predictable, particularly for children and other vulnerable groups
- Systems must be designed around human limits



Final thought

Road trauma is not random. It occurs when human tolerance is exceeded. If we design systems around human limits, we can prevent it.





THANK YOU!

