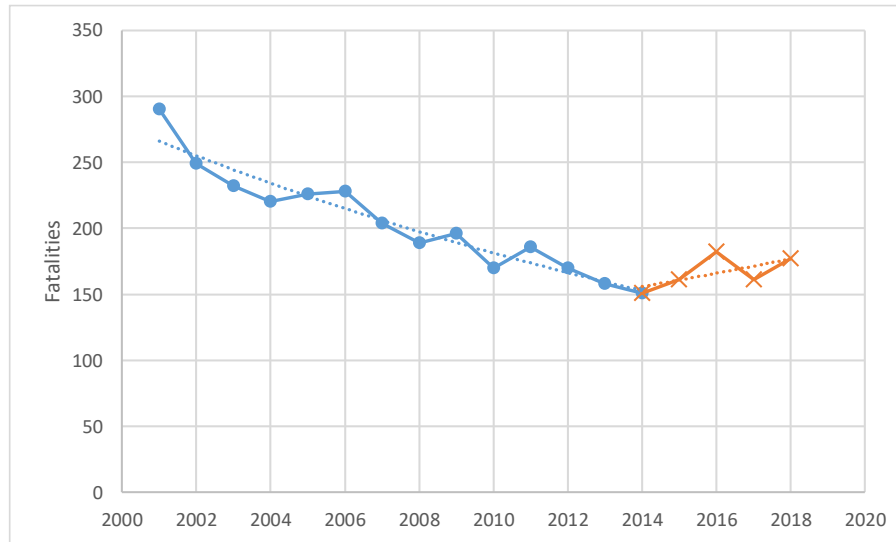


Vehicle design for pedestrian protection

DR DAVID LOGAN (MUARC)
13 NOVEMBER 2019

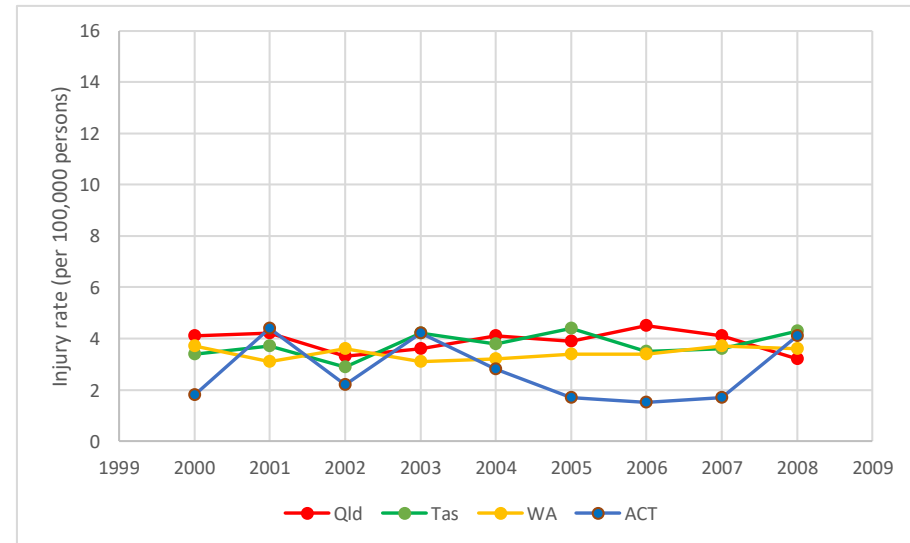
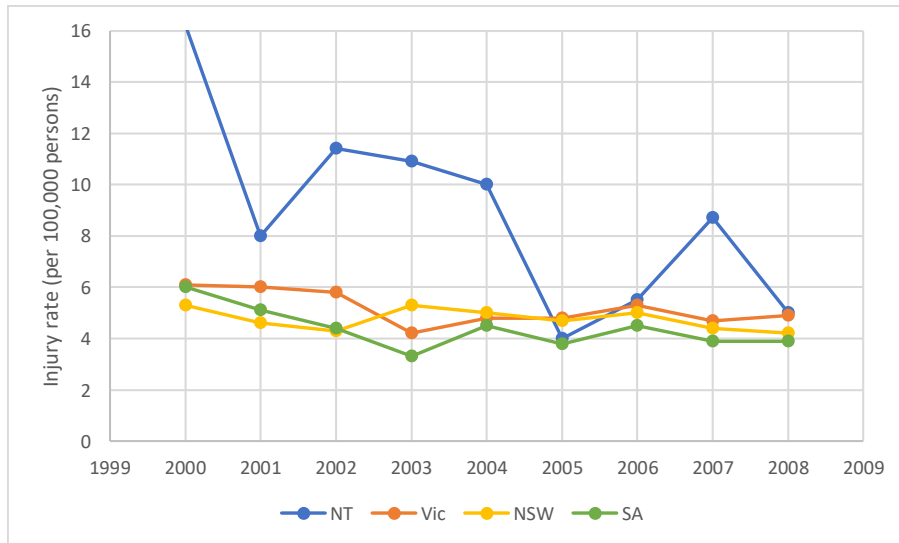


Fatalities² and injury rates³ in Australia



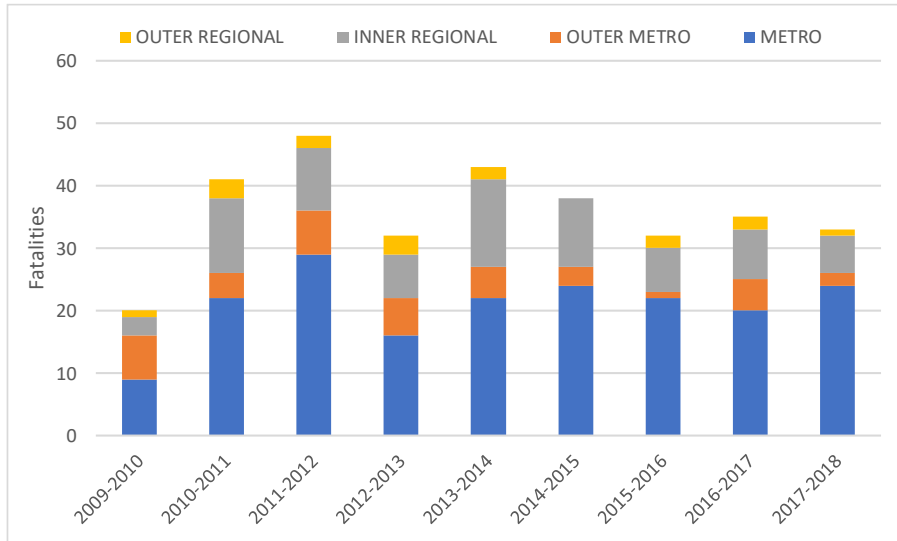
Fatalities

High threat-to-life

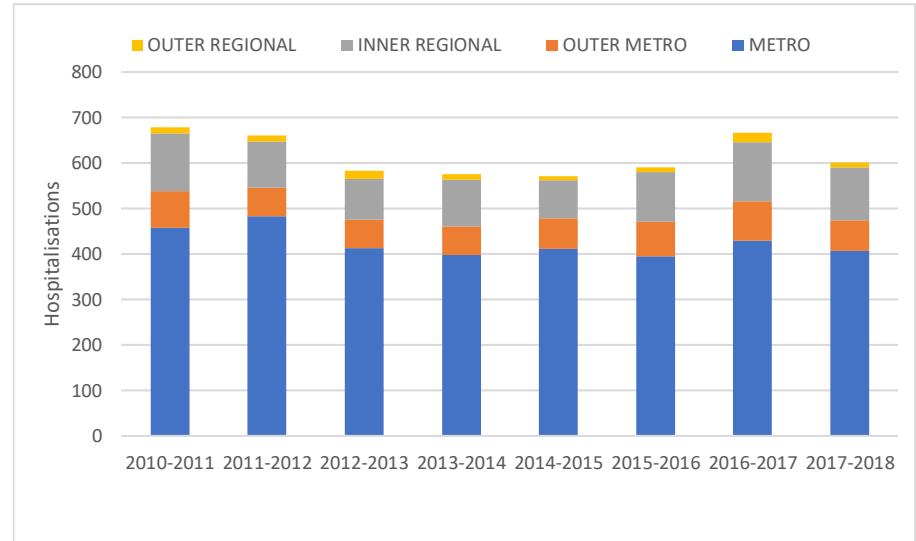


Pedestrian FSI by year, speed zone (Victoria)

Fatalities



Hospitalisations



Speed zones	F as a proportion of FSI	Ratio cf. 30-40 km/h
30-40	2.2%	1.0
50-60	3.9%	1.8
70-80	9.5%	4.4
90+	17.6%	8.1
Overall	4.7%	

Pedestrian FSI by crash type (Victoria)

Crash type (description, DCA)	F (%)	SI (%)
Nearside from kerb (100)	41	38
Far side from kerb (102)	26	24
Nearside from behind parked car (101)	4	6
At driveway (107)	1	5
On carriageway (103)	4	4
On footpath/median (106)	5	3
Walking with traffic (104)	6	2
Pedestrian other (109)	4	7
Other	9	11
Total	100	100

Vehicle-pedestrian impacts



Body regions for pedestrian injury⁴

- Head
 - Most frequently-involved and serious body region
 - Most vulnerable for fatal and AIS2+ injuries, contributing to 64% of pedestrian fatalities
 - Brain injury more likely to be from vehicle impact than road surface
- Lower limbs, including pelvis
 - Pelvic fractures
 - Knee ligament damage
- Thorax



4. Carter, E.L., Neal-Sturgess, C.E., Hardy, R.N., 2008. APROSYS in depth database of serious pedestrian and cyclist impacts with vehicles. *International Journal of Crashworthiness* 13(6), pp. 629-642.

Vehicle sources of pedestrian injury⁴

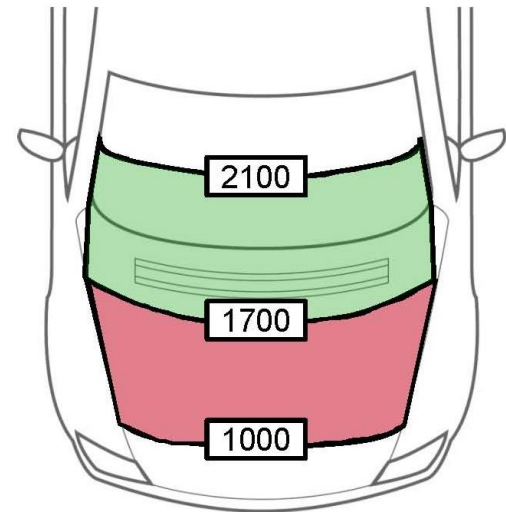
- Head
 - Adults: windscreen, windscreen surround, A-pillars, bonnet and wings
 - Children: bonnet, windscreen
- Thorax (and abdomen)
 - More common in children than adults
 - Adults: bonnet top
 - Children: bonnet leading edge
- Pelvis
 - Bonnet leading edge (mostly adults)
- Lower limbs
 - Most common injury location, but lower threat-to-life
 - Bumper (tibia/fibula, knee)
 - Bonnet leading edge (femur)



4. Carter *et al* (2008)

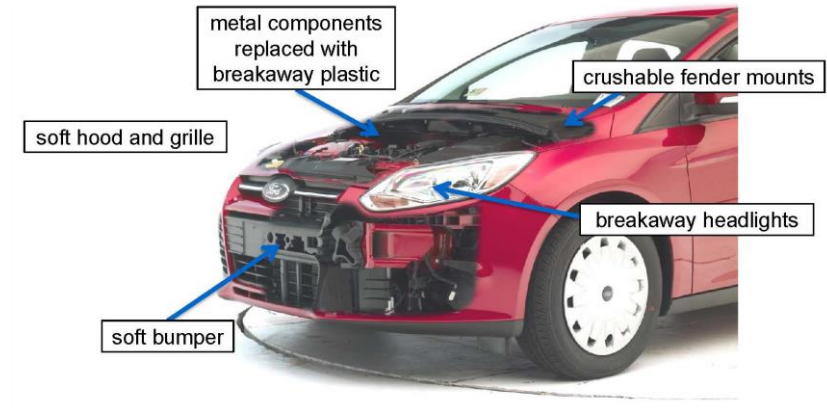
Pedestrian frontal impact regulations

- EU Directives in 2003, 2005 → Regulation EC 78/2009
 - Combination of passive and active safety features
 - Acknowledgement that high-level crashworthiness can be supplemented by crash avoidance systems aimed at mitigating or preventing impact
 - Extension to vehicles heavier than 2500 kg
- Passive protection
 - Lower legform test at 40 km/h
 - Upper legform test at 40 km/h
 - Adult and child/small adult headforms at 35 km/h
- Active protection
 - Brake assist system



Design consequences

- Bonnet surfaces must have space beneath (at least 100 mm) to the engine
- Bumper, bonnet leading edge engineered to be softer



Benefits and the future

- Benefits⁵
 - Lower limbs safer due to improved bumper design
 - Pelvis worse due to higher bonnet leading edge
 - Head injury inconclusive
 - Moderate correlation between test performance and fatality rate, as well as with incapacitating head injury
- ECE Regulation No. 127
 - Pedestrian/cyclist detection (plus AEB) to new models by Sep. 2024 (Sep. 2026 for cyclists), all vehicles by Sep. 2026 (Sep. 2028)
 - Increased adult head impact zone (A-pillar and windscreen) to new models by Sep. 2024, all vehicles by Sep. 2026
 - Reversing detection to new models by Sep. 2020, all to vehicles by Sep. 2022
 - Changes to legform and headform tests
- Regulations are European only
 - Consumer testing (e.g. EuroNCAP) driving improvements w tests

