

The Combined Effect of Vehicle Frontal Design, Speed Reduction, Autonomous Emergency Braking and Helmet Use in Reducing Real Life Bicycle Injuries

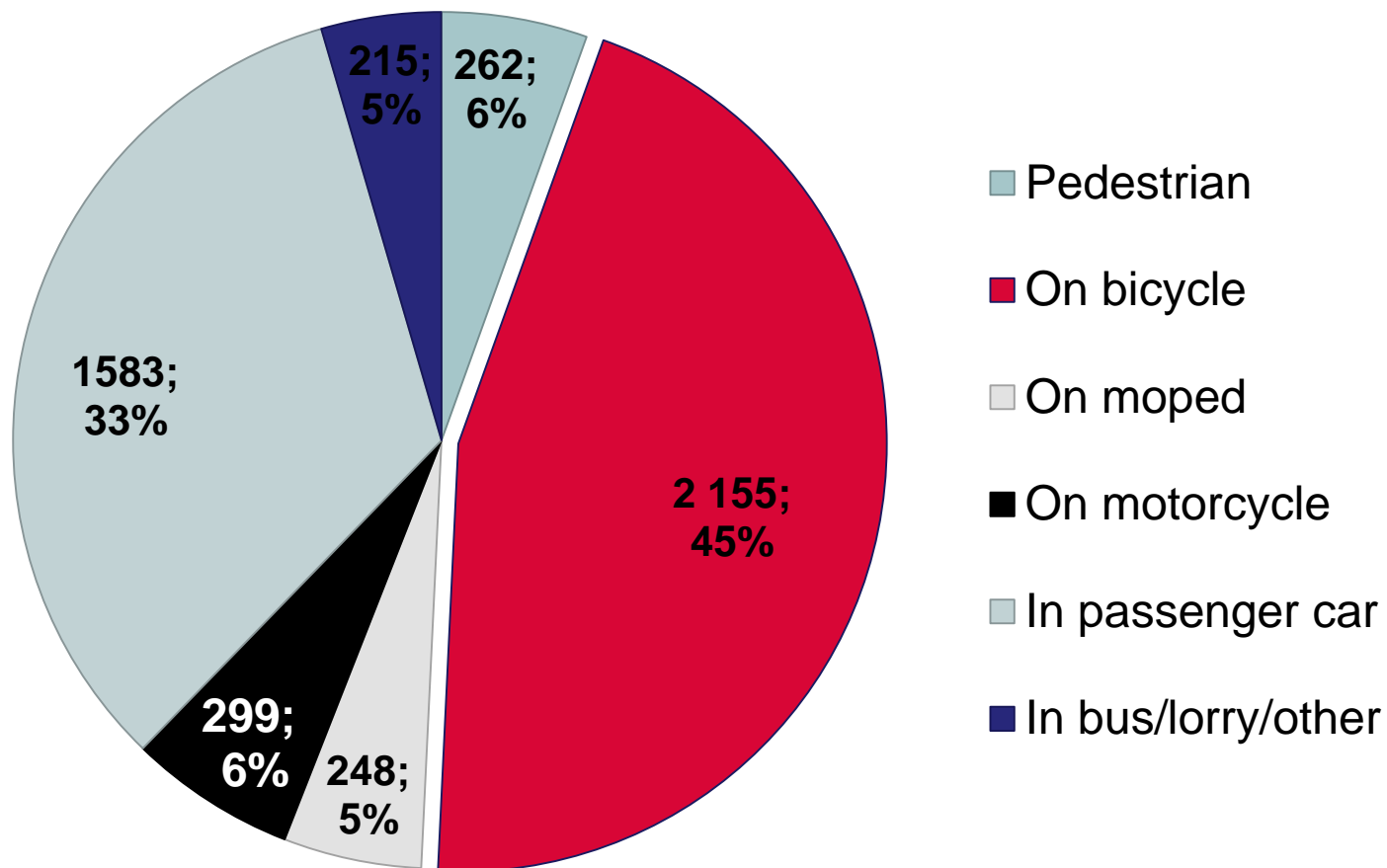
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Number/percentage of serious injuries (≥ 1 % medical impairment)



Source: STRADA, 2013.

Aim

- To evaluate the effect of friendlier car fronts on injury severity.
- To estimate the combined effect of different interventions promoting safety for vulnerable road users.

Considered interventions

- Friendlier car fronts
- Lowered speed restriction
- Helmet use
- AEB with pedestrian detection



Friendlier car fronts
Emergency braking



Speed management



Protective gear

Material

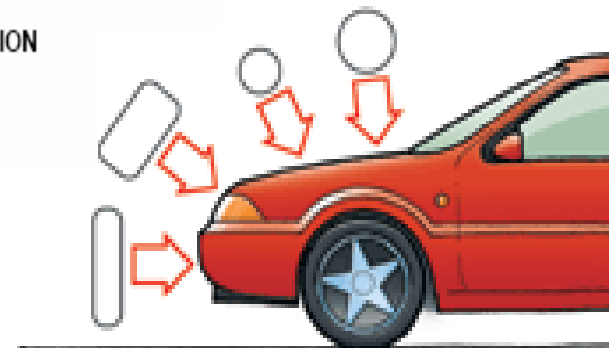
- STRADA
 - Police records and emergency hospital admission data
 - crashes between cars tested in Euro NCAP and **pedestrians** (n=1184) and **bicyclists** (n=2029).
 - Jan 1st 2003 to March 2014



SCORE:

19 (53%)

PEDESTRIAN PROTECTION



Method

- Comparing mean values and proportions of injury severity between *Euro NCAP pedestrian score (1:1-9 p, 2:10-18 p, 3:>18 p)*, *speed limit* and *helmet use*.

Injury severity classification:

- Maximum Abbreviated Injury Score (MAIS)
 - Long-term consequences:
Risk of Permanent Medical Impairment

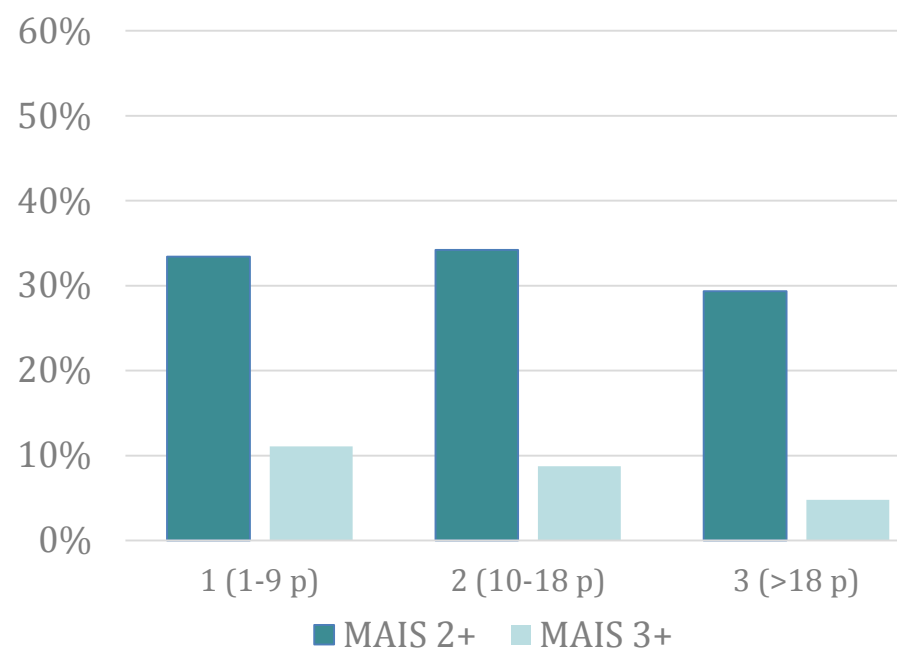
- Induced exposure for calculating the effect of pedestrian detection.

Risk of 10% or more permanent medical impairment. Malm et al (2008)

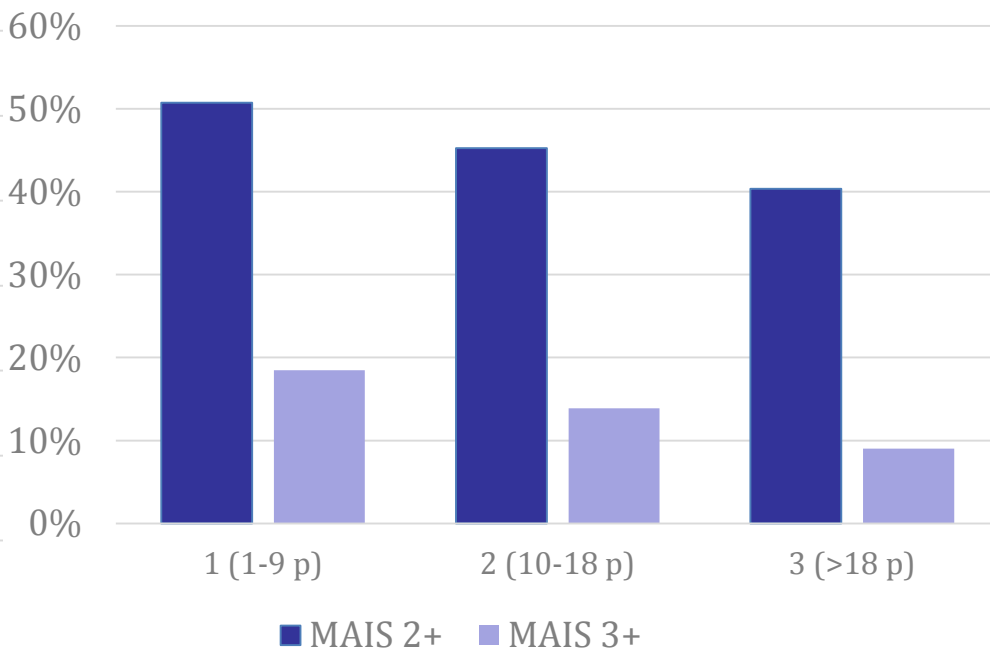
Body region	AIS 1	AIS 2	AIS 3	AIS 4	AIS 5
Head	2,5%	8%	35%	75%	100%
Cervical spine	2,5%	10%	30%	100%	100%
Face	0,4%	6%	60%	60%	n. a.
Upper extremity	0,3%	3%	15%	100%	n.a
Lower extremity	0,0%	3%	10%	40%	100%
Thorax	0,0%	0%	0%	15%	15%
Thoracic spine	0,0%	7%	20%	100%	100%
Abdomen	0,0%	0%	5%	5%	5%
Lumbar spine	0,1%	6%	6%	100%	100%
External (skin)	0%	0%	50%	50%	100%

Results

Proportions of **bicyclists** and **pedestrians** MAIS2+ and MAIS3+ injuries, grouped by NCAP pedestrian score



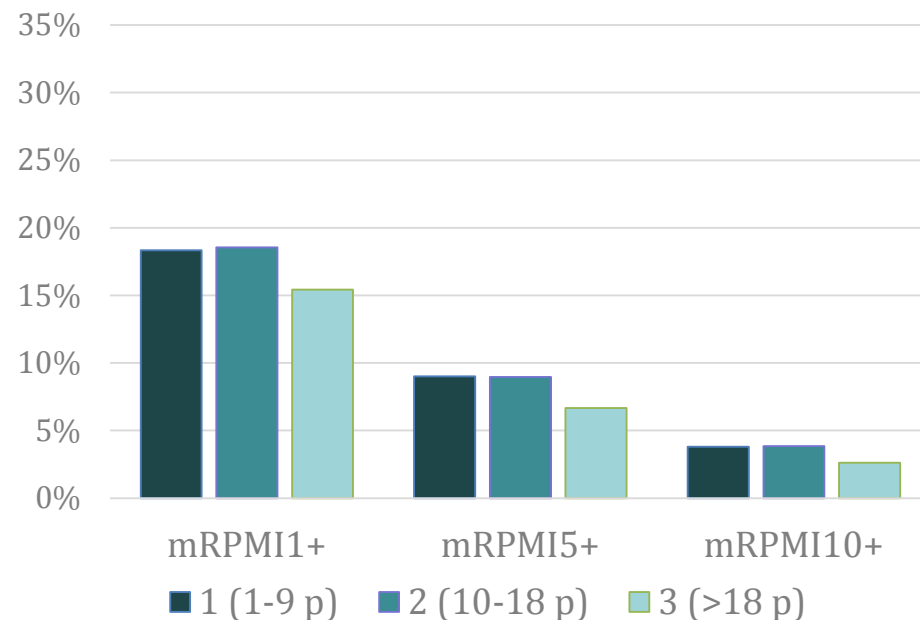
	Rel. diff. 1-3	P-value
MAIS2+	-12%	0,331
MAIS3+	-57%	0,573



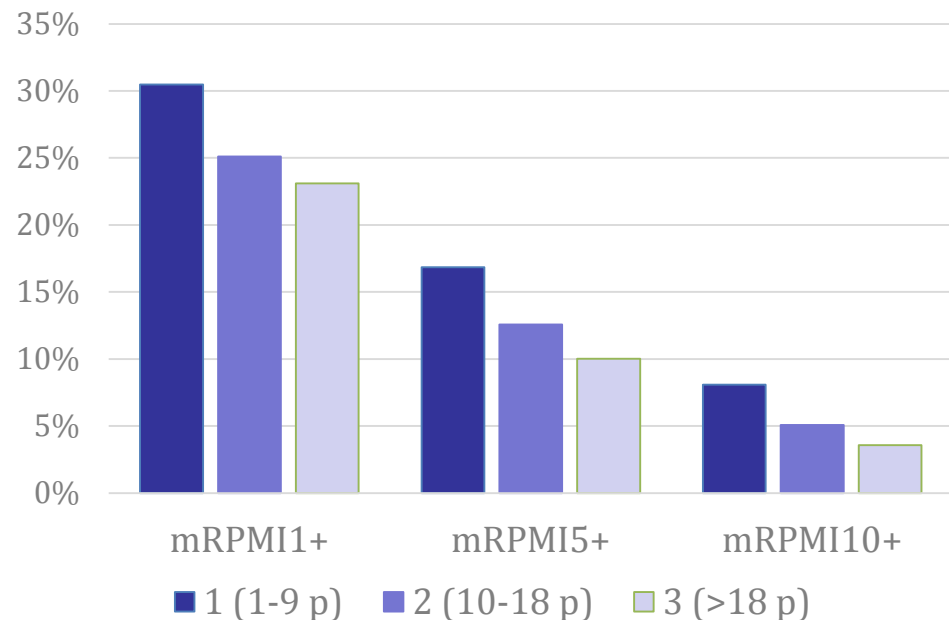
	Rel. diff. 1-3	P-value
MAIS2+	-20%	0,063*
MAIS3+	-51%	0,435

Results

Bicyclists and **pedestrians** mean Risk of Permanent Medical Impairment (mRPMI) on the 1%+, 5%+ and 10%+ levels, grouped by NCAP pedestrian score.



	Rel. diff. 1-3	P-value
mRPMI1+	-16%	0,110
mRPMI5+	-26%	0,036**
mRPMI10+	-31%	0,111



	Rel. diff. 1-3	P-value
mRPMI1+	-24%	0,008**
mRPMI5+	-40%	0,000***
mRPMI10+	-56%	0,002***

Results

Combined effect of high-performing cars, speed limit reductions and helmet use on bicyclist's injury reduction.

	mRPMI1%+	mRPMI5%+	mRPMI10%+
Car group 1 (1-9 p), all speed limits (n=515)	18%	9%	4%
Car group 3 (>18 p), 30-40 km/h speed limit, helmet (n=4)	10%	3%	1%
Relative difference	44%	70%	79%
P-value	.354	.015	.001



Results

Odds ratio calculation with induced exposure

	W/Pedestrian detection	W/O Pedestrian detection
Bicyclists + Pedestrians	2 (7)	52
Rear-end collisions	18	140
OR	0,11	0,37
R	0,30	
E	70% <i>n.s</i>	

$$1 + 1 = 3$$



Speed management



Friendlier car fronts



Helmet

Independent: -19%

-31%

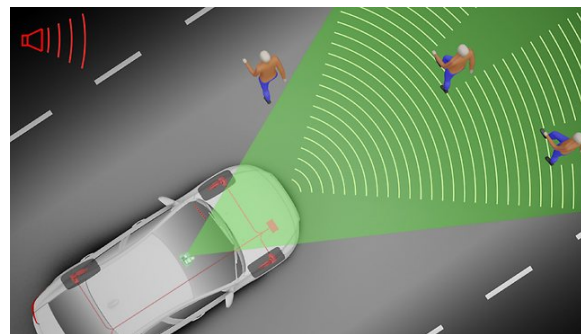
-43%

= -68%

Combined:

-79%

+AEB w/pedestrian detection -70%



90-95 % injury reduction

Conclusions

- Reductions in long-term injuries between low and high performing cars in the Euro NCAP pedestrian test.
- Combining different interventions, severe impairing injuries were reduced by around 80%, compared to around 70% if treated as independent interventions..
- .. also including benefits of AEB w/pedestrian detection the reduction could be even greater.