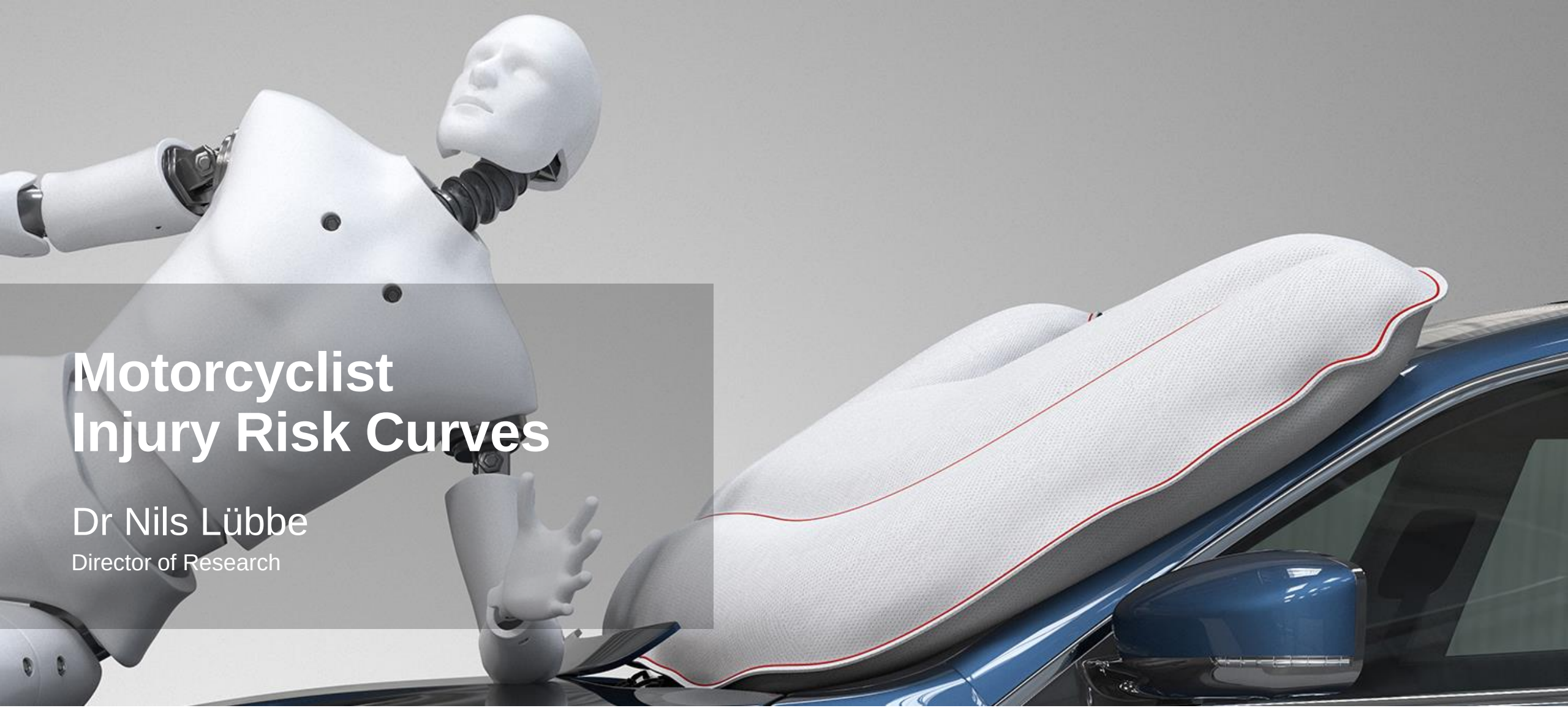

Motorcyclist Injury Risk Curves

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Motorcyclist injury risk as a function of real-life crash speed and other contributing factors

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GIDAS (German In-Depth Accident Study)

- Dresden and Hannover and their surroundings
- Rural and urban traffic to represent a mini Germany
- Work shifts night and day
- On-site investigation when injuries are suspected
- Teams with both technical and medical personnel
- At least one personal injury is required for inclusion in the database

Data selection

- L3e motorcycle cases in GIDAS 1999-2017 (n=3,209)
- Exclude crash event for worst injury not recorded (n=2,389)
- Exclude motorcycles struck from behind (n=2,285)
- Exclude VRUs, buses and trucks as crash opponents (n=2,090)
- Exclude motorcyclists who were run over (n=2,075)
- Exclude uninjured motorcyclists (n=2,049)
- Exclude motorcyclists without helmets (n=2,009)

Candidate variables

Categories	Description	Abbreviation
Motorcycle	Weight	MC.W
	Length	MC.L
	Seat Height	MC.SH
	Handlebar to Seat distance	MC.HS
Driver	Weight	Driver.W
	Height	Driver.H
	Age	Driver.age
	Protection clothes (1=yes, 0=no)	Driver.P
Crash opponent	Type of opponent (car, narrow object, wide object, crash barrier, ground)	OP.type
Crash mechanism*	Crash speed	VK
	Relative speed	Vr
	Relative speed in longitudinal or latitudinal direction according to motorcycle coordinate	Vr_x, Vr_y
	Delta-v caused worst injury	DV
	Delta-v in longitudinal or latitudinal direction according to motorcycle coordinate	DV_x, DV_y
	Driver impact on opponent with directional change (1=yes, 0=no)	Driver.impact
	Impact location on motorcycle (1=front, 0=side)	ImpactSide
Pre-crash status	Pre-crash status of motorcycle (1=unstable, 0=stable)	PreCrashStatus

Logisitic regression

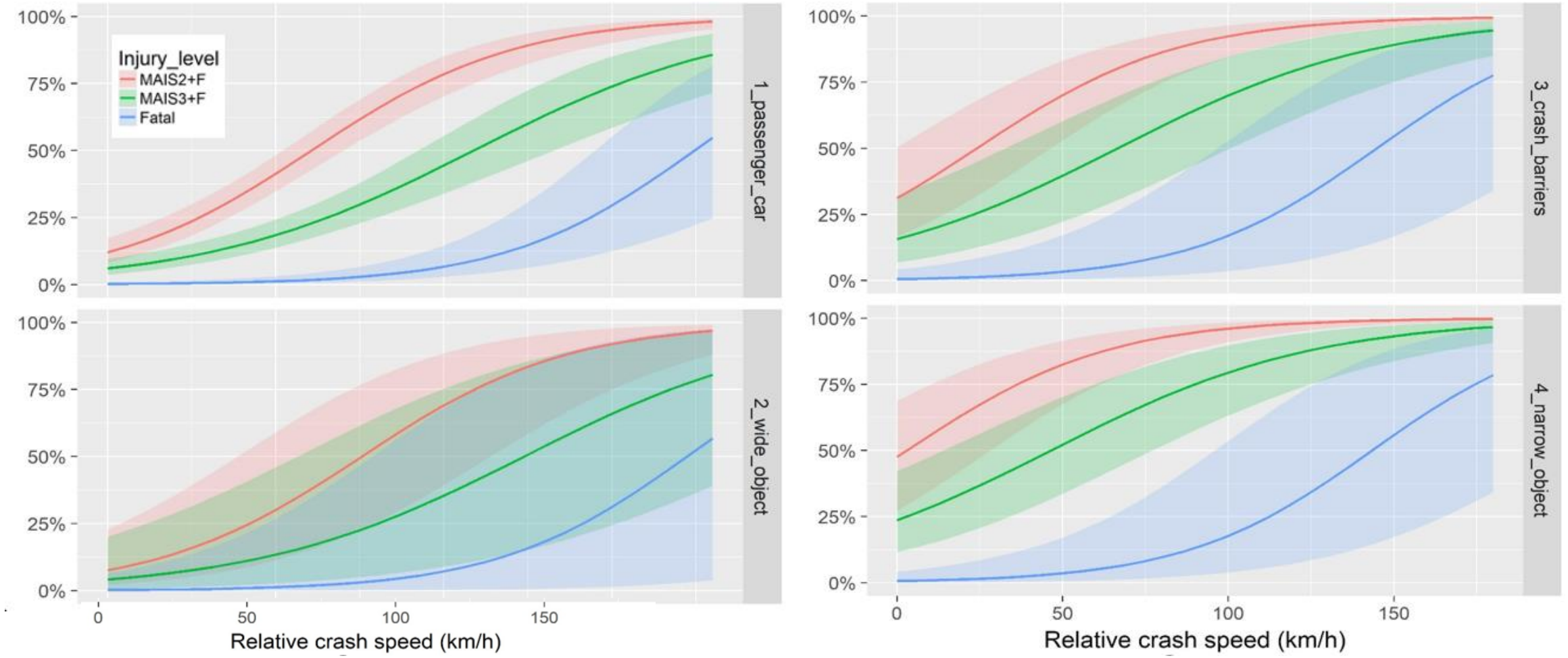
$$\mathrm{P(x)} = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}}$$

where $\mathrm{t} = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n$

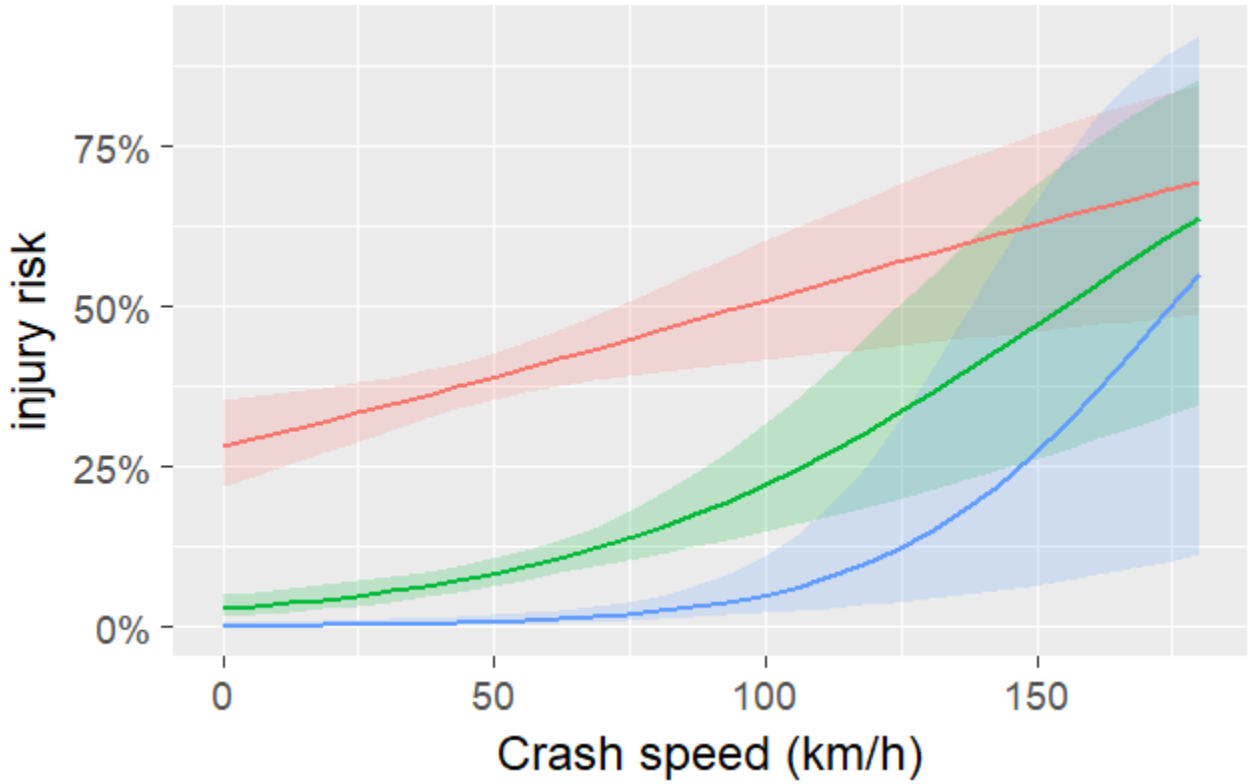
Results

	MAIS2+F	MAIS3+F	Fatal
Estimated coefficients (Standard error)			
(Intercept)	-2.256 (0.188)***	-3.952 (0.279)***	-7.175 (0.778)***
Relative speed	0.033 (0.003)***	0.025 (0.003)***	0.035 (0.005)***
Impact on front (1) or side (0)	0.158 (0.151)	0.677 (0.22)**	0.28 (0.522)
Opponent: Passenger car	0	0	0
Opponent: Narrow object	1.801 (0.359)***	1.575 (0.341)***	1.05 (0.766)
Opponent: Wide object	-0.608 (0.572)	-0.386 (0.814)	-0.019 (1.655)
Opponent: Crash barriers	1.094 (0.311)***	1.013 (0.359)**	0.857 (0.738)
Unstable (1) or stable (0) status	-0.032 (0.243)	0.495 (0.29).	1.827 (0.641)**
Impact on driver (1) or not (0)	0.047 (0.154)	0.529 (0.208)*	0.71 (0.542)
Evaluation criteria			
Resid.Dev	1166.57	717.02	149.94
AIC	880.7	445.6	137.1
Pseudo R2	0.1745	0.2322	0.3765
cvAUC (median)	**0.7263**	**0.7607**	**0.9109**

Motorcyclist injury risk as a function of real-life crash speed

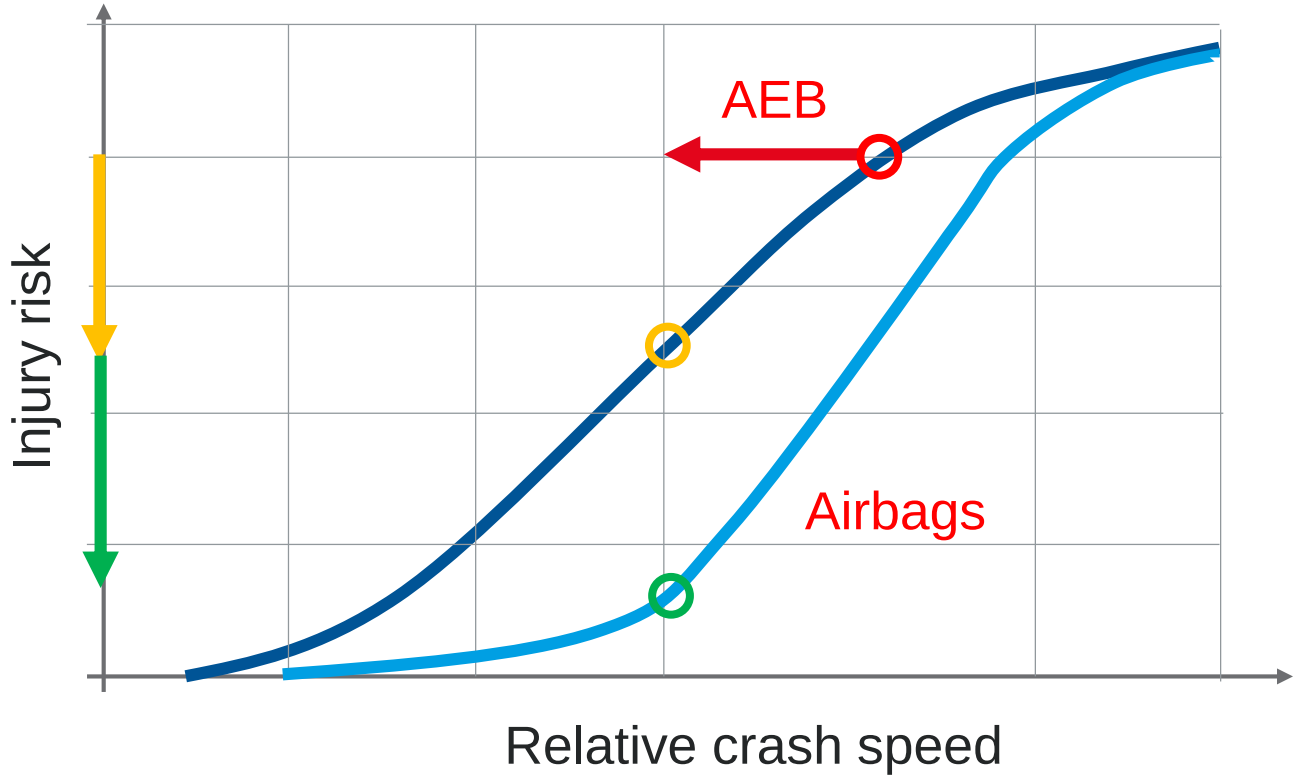


Motorcyclist injury risk for ground impact



Implications?
Appropriate speed limits

Implications?
Quantifying benefits of pre-crash and in-crash protection

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