DaCoTA

European Conference on Road Safety Data and Knowledge-based Policy-making

Session 7

Measuring, Assessing and Improving Vehicle Safety

Empirical Methods for the Evaluation of Vehicle Safety Systems

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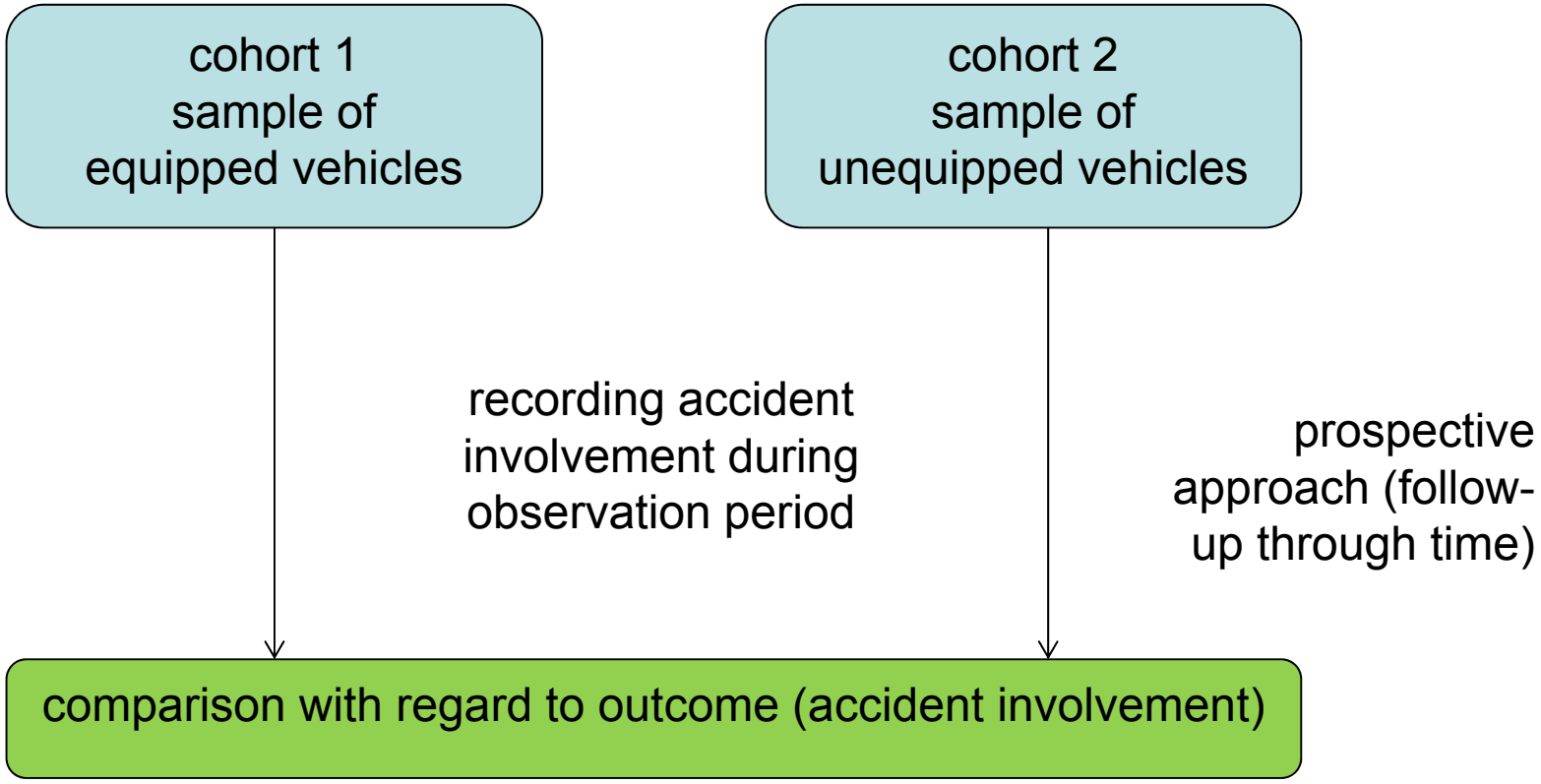
Outline

- Study Designs for the evaluation of vehicle safety systems
- Challenges
- Empirical examples for selected study designs

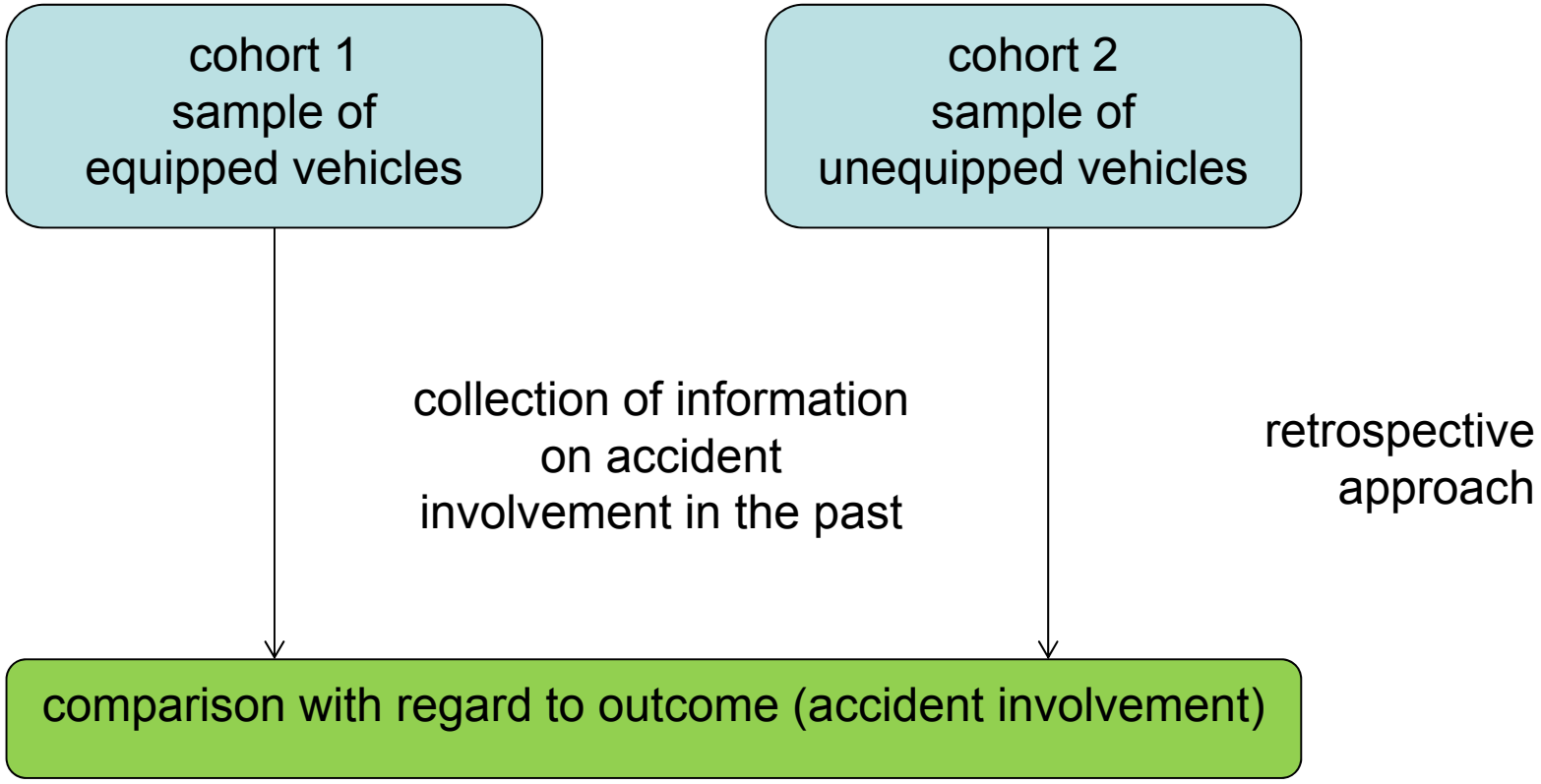
Study Designs

Cohort Study



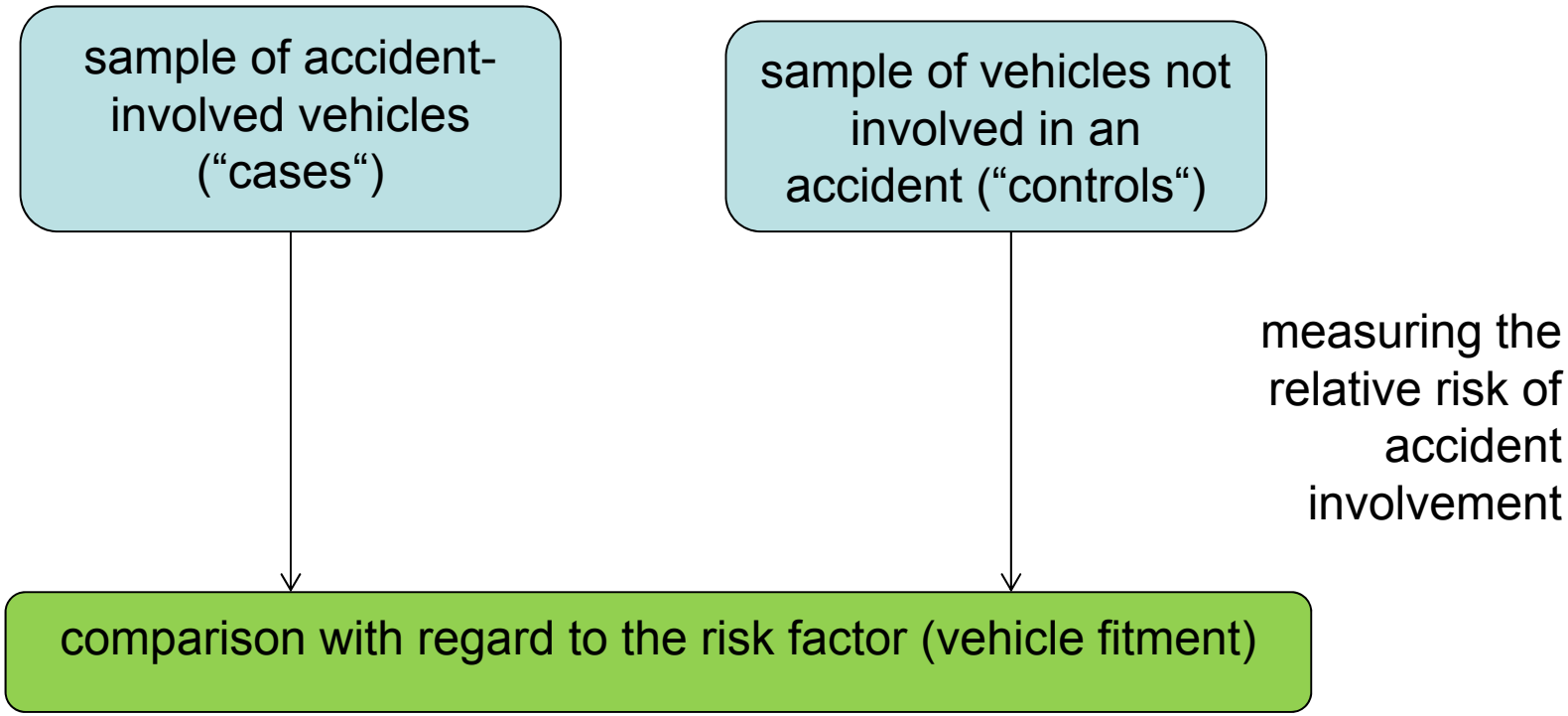
Study Designs

Accident Involvement Survey



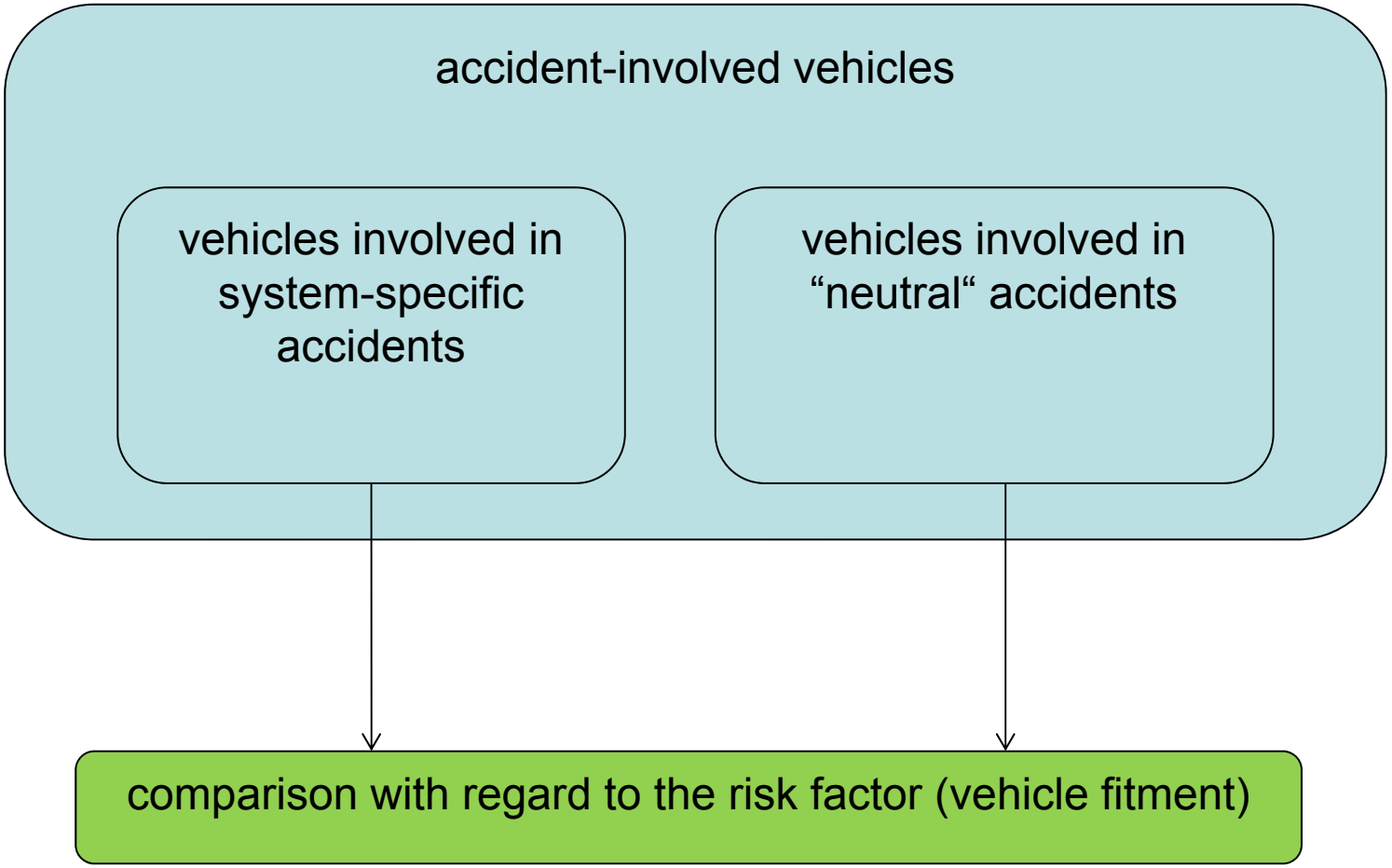
Study Designs

Case-Control Study



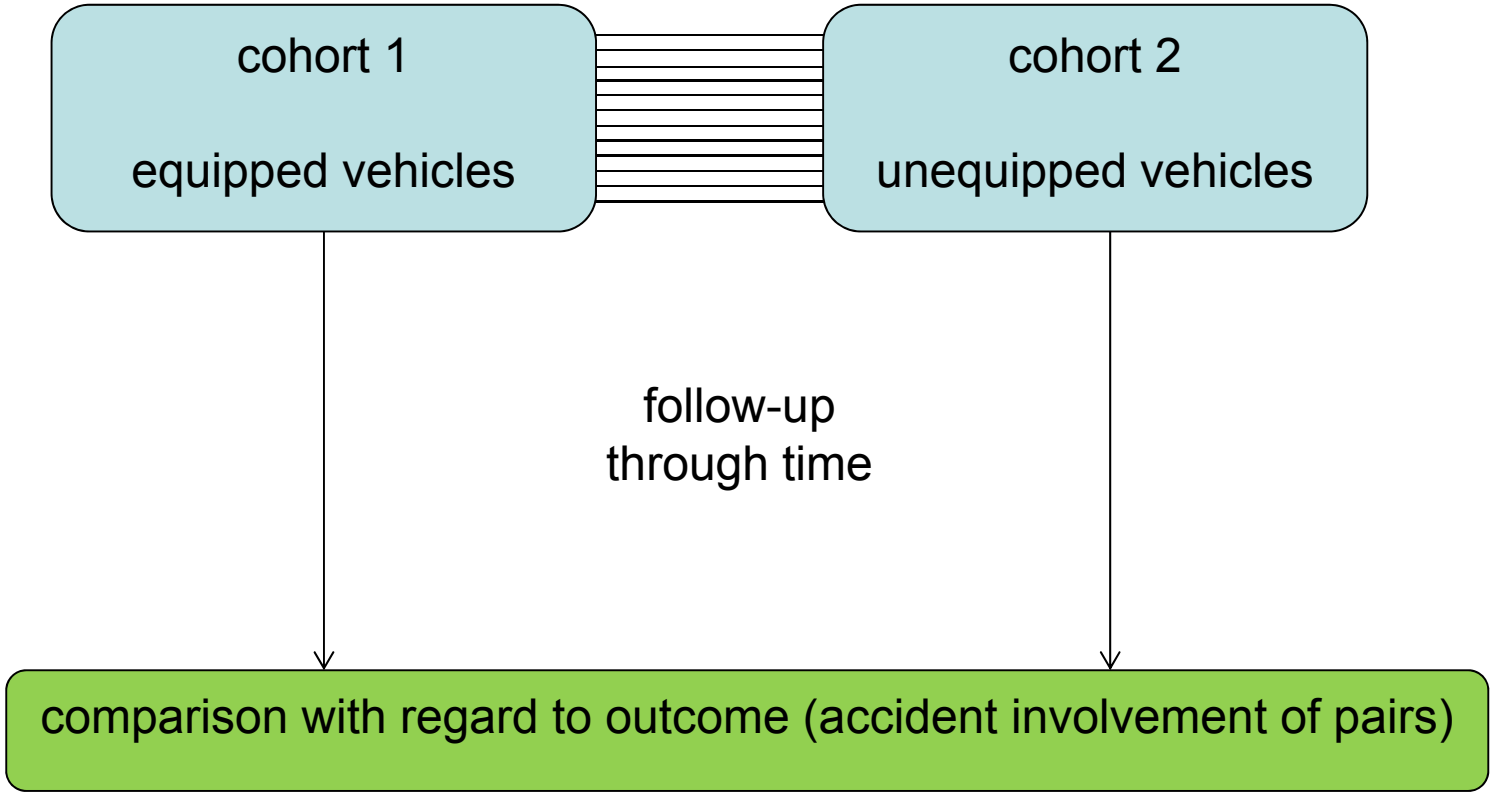
Study Designs

Induced Exposure Analysis



Study Designs

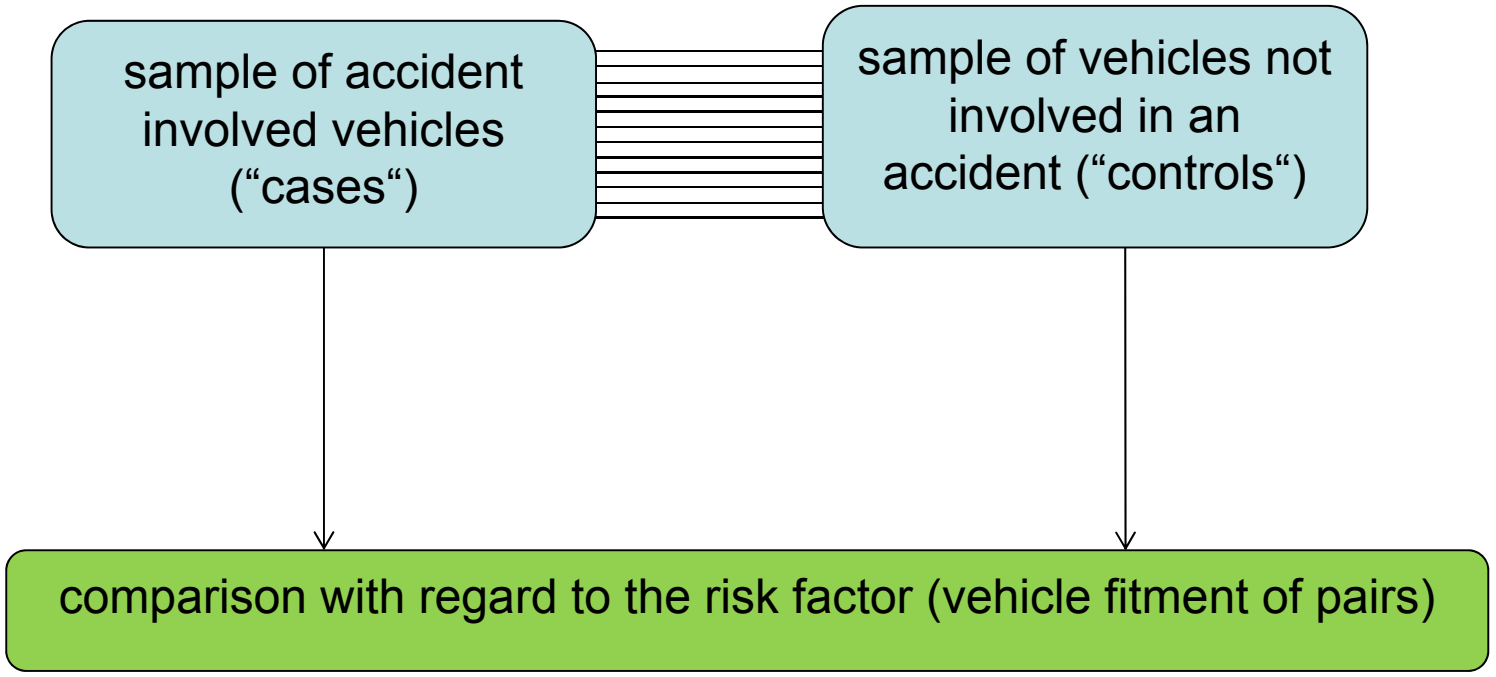
Matched Cohort Study



Matching criteria: vehicle (or driver) characteristics

Study Designs

Matched Case-Control Study



Matching criteria: vehicle (or driver) characteristics

Study Designs

Challenges

- All possible study designs are faced with the problem that in addition to the Safety system to be assessed (say system S) also other systems (say systems A, B, C, …) may be present in a vehicle. It might even be the case that if system S is to be found in a vehicle one always or nearly always will also find system A in the vehicle. Under these circumstances it might be difficult or even impossible to measure the “pure” effect of system S.
- What are the most frequent combinations of eSafety systems (“bundles” of systems) fitted in vehicles?
- Are there significant interactions between individual systems in the sense that the efficacy of system S is affected by the presence of system A?
- Data on vehicle fitment are rarely to be found in routine data bases

Induced Exposure Analysis

Data (GIDAS data provided by Volkswagen AG)

- n=10.270 accident-involved passenger cars (1995-2011)
- System to be evaluated: ESP

- System-specific accidents: car was skidding
- Neutral accidents: no skidding

- Possible confounders
  - tyre age (<3 years; 3-5 years; 6 years and older)
  - road condition (dry; other)

Induced Exposure Analysis

Results: Odds Ratio

ESP	skidding		total
	no	yes	
yes	2792	102	2894
no	6602	774	7376
total	9394	876	10270

- OR = (102/2792) / (774/6602) = 0.31

Induced Exposure Analysis

Results: Adjusted Odds Ratio (binary logit model)

- Model estimation results (probability of “skidding=yes” is modelled)

Typ-3-Effektanalyse			
Effekt	DF	Waldsches Chi-Quadrat	Pr > ChiSq
ESP	1	95.9577	<.0001
ROAD	1	297.8580	<.0001
TYREAGE	2	6.3748	0.0413

Analyse Maximum-Likelihood-Schätzer						
Parameter		DF	Schätzwert	Standard-fehler	Waldsches Chi-Quadrat	Pr > ChiSq
Intercept		1	-1.2657	0.0769	270.9430	<.0001
ESP	with ESP	1	-1.0755	0.1098	95.9577	<.0001
ROAD	dry	1	-1.2515	0.0725	297.8580	<.0001
TYREAGE	0-2years	1	-0.2295	0.0912	6.3341	0.0118
TYREAGE	3-5years	1	-0.1476	0.0927	2.5329	0.1115

- Adjusted Odds Ratio (ESP vs. no ESP): 0.34 [=exp(-1.0755) / exp(0)]

Matched-pairs Analysis

Data (from German FAS project)

- N=1.250 heavy trucks as study units (from 270 companies)

- **Matched cohort analysis:**
- Cohort 1: 715 vehicles equipped with ACC, ESP and LGS (Lane Guard System)
- Cohort 2: 535 reference vehicles (unequipped)
- Follow-up period ≈ 2 years
- Evaluation criterion: accident involvement during the observation period (yes / no)
- 1:1-matching by random within the respective company (resulting in 527 pairs of vehicles)

Matched-pairs Analysis

Results: Matched Odds Ratio

Equipped vehicle	Reference vehicle		total
	inv. in acc.	not involved	
inv. in acc.	19	43	62
not involved	67	398	465
total	86	441	527

- OR=43/67=0.6418
- McNemar's test: $\chi^2=(43-67)^2/(43+67)=5.236$ (df=1) sig=0.0221
- Unmatched OR (for comparison): only 0.6945

Matched-pairs Analysis

- Equipped and reference vehicles differ with regard to vehicle age and km driven in the study period
- Therefore: Controlling for confounders by using a statistical model
- Conditional logit-model for matched cohort data
- Based on n=110 discordant pairs
- Additional predictor variables in the model:
  - km driven in the study period (mileage – in 100.000 km)
  - Year of manufacture
  - Truck manufacturer (2 categories)
  - Area of operation (local or regional / far distance transport)

Matched-pairs Analysis

Results: Adjusted Matched Odds Ratio

- Model estimation results (probability of “accident involvement=yes” is modelled)

Typ-3-Effektanalyse			
Effekt	DF	Waldsches Chi-Quadrat	Pr > ChiSq
Cohort	1	6.5426	0.0105
Mileage	1	7.1693	0.0074
Year of Manufacture	1	0.3853	0.5348
Truck Manufacturer	1	0.5601	0.4542
Area of Operation	1	0.0126	0.9107

Analyse Maximum-Likelihood-Schätzer						
Parameter		DF	Schätzwert	Standard-fehler	Waldsches Chi-Quadrat	Pr > ChiSq
Cohort	equipped	1	-0.8841	0.3457	6.5426	0.0105
Mileage		1	0.5509	0.2057	7.1693	0.0074
Year of Manufacture		1	0.0723	0.1165	0.3853	0.5348
Truck Manufacturer	Manuf. A	1	0.3896	0.5206	0.5601	0.4542
Area of Operation	far distance	1	-0.0707	0.6301	0.0126	0.9107

- Adjusted Odds Ratio (equipped vs. reference): 0.41
- Adjusted Odds Ratio (Mileage): 1.74

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Thank you for your attention!